FORECAST: SWEEPING CHANGES AHEAD FOR THE AUTO INDUSTRY

Technology Review

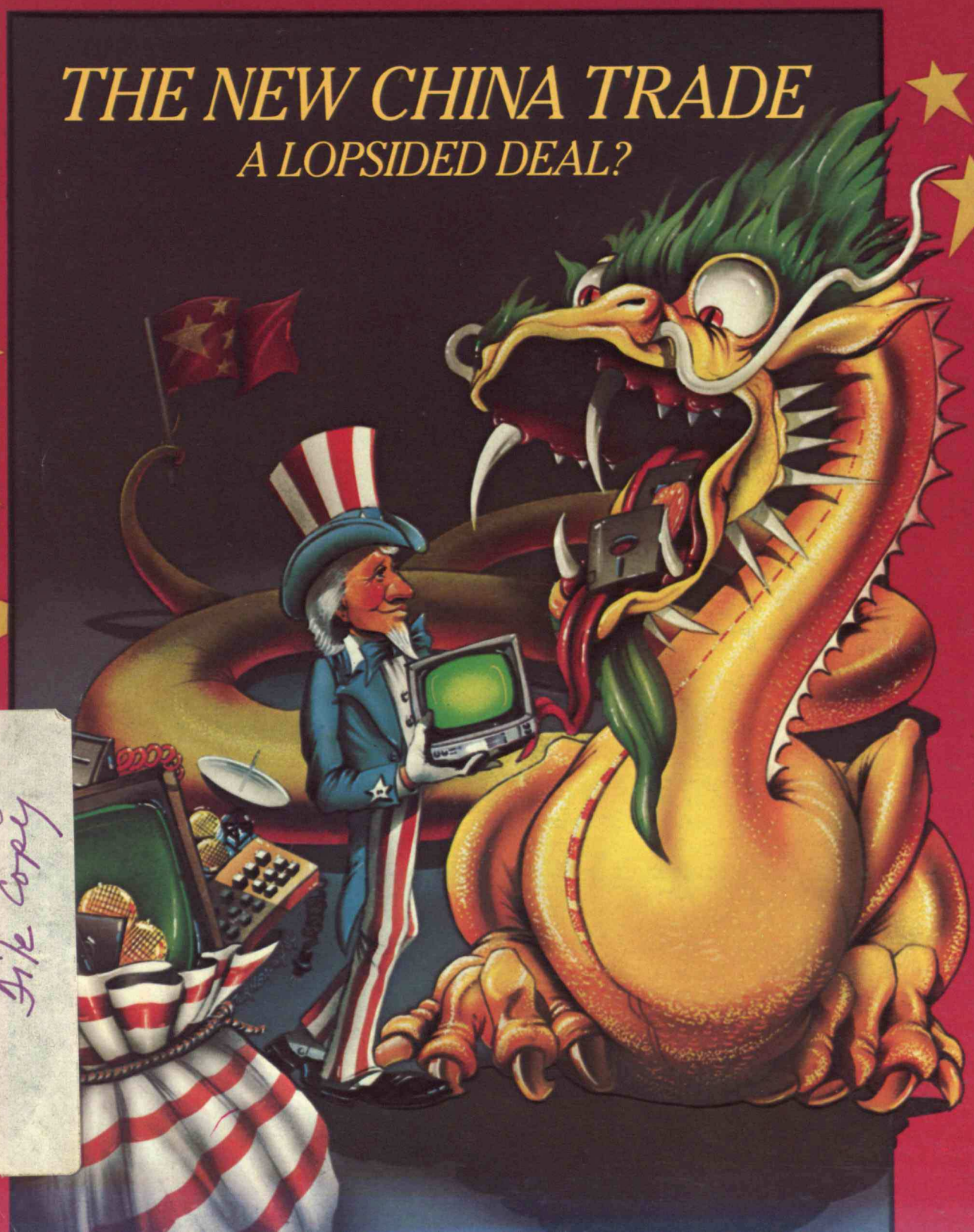
EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

OCTOBER 1984

$3.00

THE NEW CHINA TRADE

A LOPSIDED DEAL?



Sandra Knight
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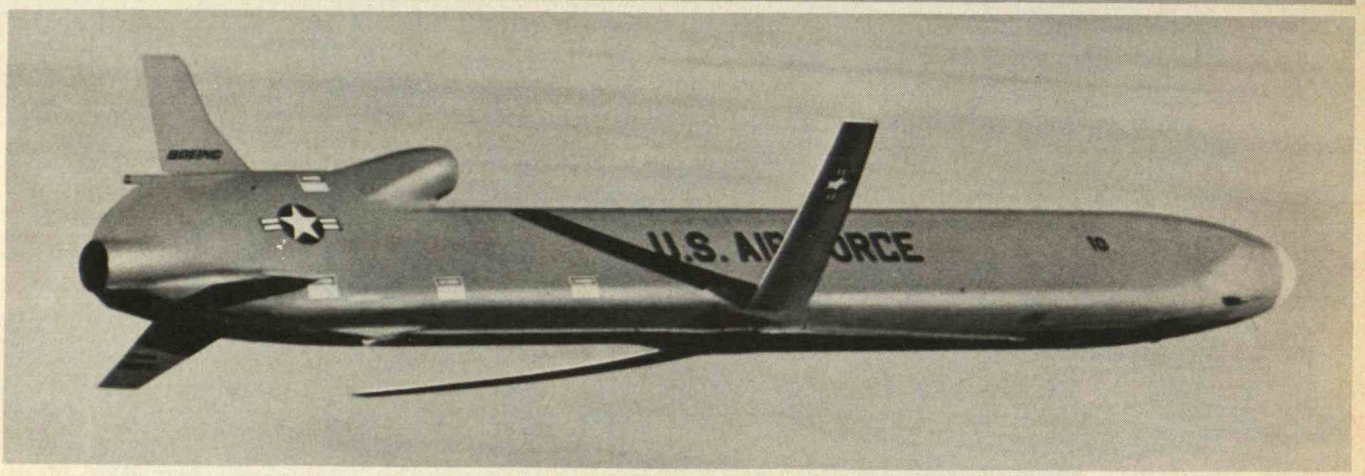

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OCTOBER 1984 VOL. 87 NO. 7

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

TechnologyReview

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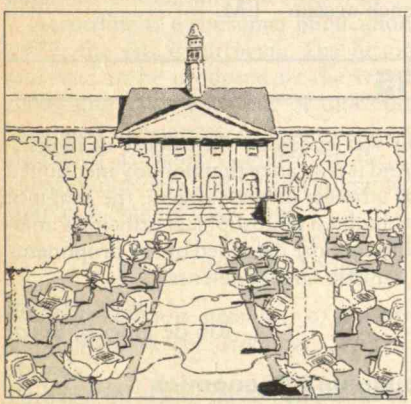

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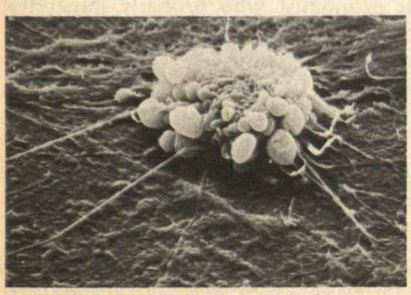

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Cover illustration by
Paul Turnbaugh
Design by Nancy Cahners

TechnologyReview

PUBLISHER
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Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (January, February/March, April, May/June, July, August/September, October and November/December) at the Massachusetts Institute of Technology. Two special editions are provided for graduate (pp. A1-A32) and undergraduate (pp. A1-A32 and B1-B24) alumni of M.I.T. Entire contents © 1984 by the Alumni Association of M.I.T. Printed by Lane Press, Burlington, Vt. Second-class postage paid at Boston, Mass. and additional mailing offices. Postmaster: send address change to M.I.T., Room 10-140, Cambridge, Mass. 02139.

Editorial, circulation, and advertising offices: *Technology Review,* Room 10-140, Mass. Institute of Technology, Cambridge, Mass. 02139 (617) 253-8250.

Advertising representatives:
The Leadership Network: 254 Fifth Ave., New York, N.Y. 10001 (212) 684-5500; Benson Co., Park Ridge, Ill.; Colin Smith Agency, Berkeley, Calif.; Joe DeLone & Associates, Riverside, Conn., and Lincoln, Mass.; and McKeldin Co., Atlanta, Ga.

Littel-Murray-Barnhill, 1328 Broadway, New York, N.Y. 10001 (212) 736-1119.

Subscription inquiries and change of address: Room 10-140, M.I.T., Cambridge, Mass. 02139 (617) 253-8292.

Prices:
Single current copies $4 U.S., $5 Canada, $7 foreign. Subscriptions, one year: $24 U.S., $34 Canada, $44 foreign. Back issues available. All prices U.S. funds.

U.S.A. newsstand distribution by Eastern News Distributors, Inc., 111 Eighth Ave., New York, N.Y. 10011.

FIRST LINE

Our Shaggy Elephant

It all began more than a year ago in an M.I.T. science writing class. A talented undergraduate submitted for possible use in *Technology Review* a beautifully written account of the discovery in the U.S.S.R. of ova from a woolly mammoth frozen in arctic ice. This long-preserved material was eventually used, according to the account, to breed a mammoth-elephant hybrid called a "mammontelephas", from the Russian *mammonth* and the Greek *elephas,* with a biological name *Elephas pseudotherias.* The principals in this scientific achievement were said to be a Dr. Sverbighooze Nikhiphorovich Yasmilov of the University of Irkutsk and a Dr. James Creak of M.I.T.

It took us a few hours to appreciate the skill with which Diana ben-Aaron had turned an assignment in science writing into a brilliant exercise in parody, and soon enough we resolved to share ben-Aaron's achievement with our readers in celebration of All Fools' Day. Hence the feature on page 85 of our April 1984 issue.

But, as Robert Cooke, science editor of the *Boston Globe,* noted in a front-page feature late last summer, "Some folks there are who cannot take a joke." For early last May we were startled to find Diana's science nonsense taken seriously by the *Chicago Tribune* and subsequently by a number of other newspapers that subscribe to the *Tribune*'s syndicate service. Eventually *Family Weekly,* a Sunday supplement distributed in over 350 U.S. newspapers, carried the story. Meanwhile, this editor has sought to explain the April Fool's Day tradition to a biologist at the Chettiar Research Centre of Madras; and Charles Ball of the M.I.T. News Office found himself struggling to tell a Paris journalist, "N'est pas vrai!" in his best French accent.—J.M.

LETTERS

History Ditches BMD

Jonathan Tucker's "The Fallacy of Laser Defense," Carolyn Meinel's "Fighting MAD," the Bethe-Teller exchange, and Herbert Lin's "The BMD Debate: Deja Vu" (*April, pages 30, 31, 38, 50*) give a sense of complete hopelessness. The world will never get rid of the specter of global nuclear war and continuous escalation of weapons systems. The historical approach advocated by Carolyn Meinel might give some insights.

Military history seems to be about the alternative predominance of shield (defense) and spear (offense). For instance, the battle of Crécy might be thought of as the victory of missiles over a defensive system (the knights' armor).

The trench warfare of World War I was a battle between essentially defensive systems; the bloody sacrifice of millions of lives was ended by the offense of tanks.

And it is strange that nobody mentioned that ultimate defense system, the Maginot line, built on philosophical principles analogous to those defended by the proponents of ballistic missile defense.

Jerzy Lepecki
Rio de Janeiro, Brazil

Household Economics

One economist who properly integrates the household into the operation of the economy is Wassily W. Leontief, who builds it into the input as well as the output side of the system. Richard Stone, at Cambridge University, has done the best micro-input/output studies of the household.

Both would undoubtedly be delighted to help further document what Rosalind Williams ("*The Other Industrial Revolution: Lessons for Business from the*

Home," July, page 30), calls the economy's "dependence on housekeeping, both familial and environmental." Actually, Leontief has also charted environmental costs in detail in the table he set up for the Environmental Protection Agency more than a decade ago, which is presumably kept up to date.

Gerard Piel
New York, N.Y.

Mr. Piel is publisher of Scientific American *and the current president-elect of the American Association for the Advancement of Science.*

Reagan as a Cowboy

Lawrence E. Beckley decries (*April, page 3*) your January cover of President Reagan as a "rootin' tootin' cowboy" astride the bucking bronco of technology. Maybe in Winchester, Mass., it is an affront, but not out West. He's hanging' on, ain't he?

Jeff Dennis
Berkeley, Calif.

Toxic Airbags?

Why doesn't anyone write about what's in the airbag? (*"New Airbags: Low Tech, Low Price" by David Kennedy, April, page 78.*) It's not air, is it?

According to a consumer publication in 1979, the gas is nitrogen. The nitrogen was said to be produced by the reaction of sodium azide with one or more other unnamed substances. Sodium azide was described as being classified by the Occupational Safety and Health Administration as a "highly toxic solid."

Jeffrey W. Gorss
Saratoga Springs, N.Y.

William Haddon, president of the Insurance Institute for Highway Safety, responds:
Airbags, including those being sold as an option by Mercedes Benz, are inflated by harmless nitrogen gas generated by specially formulated sodium azide propellants. Sodium azide has been used in a number of other ways, including as a soil fumigant and as a pharmaceutical agent for treating high blood pressure.

Studies by Battelle Columbus Laboratories, Arthur D. Little, and Virginia's Automotive Occupant Protection Association document that the use of sodium azide in airbags poses no significant environmental or other risks. The toxicity of sodium azide is certainly no greater than that of many other substances used in automobiles, including battery acid, antifreeze, and gasoline. And unlike these substances, the azide in airbag inflators is hermetically sealed in hardened steel cases, and the public never gets to touch or breathe this chemical.

Two Ways to Improve *Monarch*

I have a suggestion and a question about the human powered aircraft *Monarch (July, page 78)*. First, if the *Monarch's* wing is a true airfoil and the wing covering is fairly impermeable, then partially evacuating the wing would add buoyancy and thus reduce the plane's net weight. This in turn would lower the horsepower demand on the human motor. I understand the rules of the Kremer Prize forbid the use of lighter-than-air gases. But perhaps they are silent on vacuum. If so, then evacuation would be a legal gimmick, just as the stored-energy battery system now used is a gimmick. In any case, the plane would be easier to fly and bring us closer to the time when would-be pilots who are not professional athletes can get off the ground under their own power.

My question refers to *Monarch*'s energy transmission system. Everything I have read or seen leads me to think it is a conventional single-speed bicycle-type system. Yet newer systems, such as the Bio-Cam, have been shown to be significantly more efficient. Since efficiency is one of the two names of the game (the other being weight reduction), I find it incredible if neither MacCready nor anyone at M.I.T. has ever thought to incorporate a Bio-Cam or an equivalent in their respective craft.

Gerald Shirley
Mt. Vernon, N.Y.

Mark Drela, Monarch *team member:*
Although evacuating the wings to reduce the aircraft's weight would probably be legal, it would not be feasible. Atmospheric pressure would create a crushing force of about four tons on each of the wing's 55 ribs. Each two-ounce rib is constructed primarily of plastic foam and certainly would not withstand this kind of abuse. Making the wing strong enough to withstand atmospheric pressure would add far more weight than the three-pound reduction created by evacuation.

Continued on page 62

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ROBERT C. COWEN

The Serious Search for Cosmic Company

GERALD Hawkins—the astronomer who "decoded" Stonehenge—calls it humankind's next "mindstep." Planetary scientist Carl Sagan prefers the more ponderous term "deprovincialization." However you phrase it, humanity now seems to be preparing for the next perceptual leap in understanding its place in the cosmos, as it begins to devote serious scientific resources to the search for extraterrestrial intelligence (SETI).

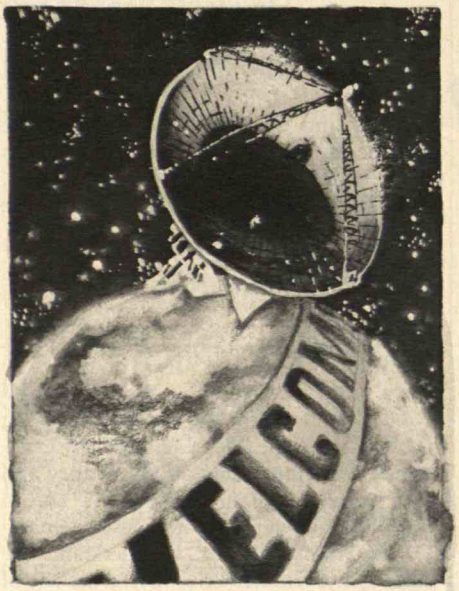
This search is now being welcomed into the scientific mainstream. It has its own place in the spectrum of official astronomical concerns as Commission 51 of the International Astronomical Union (IAU). This new status was reflected in the first IAU SETI symposium held in June at Boston University. There, perhaps for the first time, the subject was treated less as a somewhat suspect avocation of a few enthusiasts and more as sound research.

Hawkins and Sagan make the point that history has seen successive steps away from Earth-centered thinking. First Earth, then the solar system, then our galaxy were seen as occupying no special place in the universe. In each case, the new perspectives spread from a few leading thinkers or researchers to become part of the consciousness of much of humankind. Now, thanks to advances in microelectronics, scientists can begin the first substantial searches for the universality of life.

Origin of Life

A few small, admittedly inadequate, searches have been made over the past few decades. However, powerful new SETI technology is being developed in two major U.S. projects. One, Project Sentinel, is already under way, while the other, sponsored by the National Aeronautics and Space Administration, should have started by now. Both will use equipment that monitors 8 million channels simultaneously to listen for signals that aliens might beam through space. (*See "Renaissance in the Search for Galactic Civilizations" by Eugene F. Mallove, January, page 48.*)

With such projects under way, IAU symposium chairman Michael D. Papagiannis of Boston University pointed out, scientists have "finally entered the experimental phase of the search for extraterrestrial life." But with SETI's new status has come an obligation to tone down speculation and get on with basic research. Colorful, and often wild, discussions of what alien life might be like have been stimulating, but at this stage they are scientifically fruitless.



Colorful discussions of what alien life might be like are scientifically fruitless.

This is especially true of attempts to estimate the likelihood that life exists elsewhere in the universe. As Leslie E. Orgel of the Salk Institute of Biological Sciences explained at the symposium, researchers have some evidence that the sort of chemistry needed for the rise of life from inanimate substances is a natural mechanism. Thus, life is not quite the miracle that some skeptics have suggested. But scientists are only beginning to understand what happened on Earth, let alone what might happen elsewhere. For example, Orgel said his group is experimenting with artificial templates that direct molecular synthesis much the way DNA or RNA molecules naturally match basic elements. The templates pair subunits so that specific structures such as the genetic blueprint of a protein can be replicated. The experiments show that lead templates give anomalous products, whereas zinc templates give subunits of DNA or RNA.

According to Orgel, that is what SETI is all about at this stage—trying to understand the basic chemistry that might have been involved in the rise of life on Earth. But he added that experimenters are still very far from being able to replicate specific biological molecules. So-called "primitive Earth" experiments yield a mixture of products, most of which are unwanted. This is not surprising, says Orgel, as primitive Earth had billions of years to conduct "experiments." Given this ignorance, he questions how people can think that "their thoughts are reasonably rational" when they try to estimate the probability that life has arisen elsewhere.

Charles Seegar of San Francisco State University made a similar point regarding a "paradox" attributed to the late Enrico Fermi: if the rise of advanced civilizations and space colonization are at all likely, aliens should have been to Earth by now. Yet there is no sign of them. Does this imply that aliens do not exist or that space colonization may be undesirable? Seegar warned that "ignorance—enormous ignorance—allows the full range of human imagination." He added, "Don't call this the Fermi paradox. There's nothing paradoxical about it. It's just ignorance."

There's wisdom in such warnings. It's better to settle down to the serious work that SETI programs can do now and put such speculations on the proverbial back burner. Fanciful as it may have seemed just a decade ago, we are likely, within a century, to have a meaningful answer to the question of whether we are alone.

If a SETI scanner does detect an unambiguous transmission from another civilization, it will be one of the most momentous discoveries in all human history. On the other hand, if diligent searching with increasingly powerful equipment turns up nothing by, say, the year 2084, this will not prove that alien civilizations do not exist. But it will imply that, for all practical purposes, we may be alone.

Either way, humanity would make a major advance in self-awareness. This is why SETI may be one of the most important research efforts yet undertaken. □

ROBERT C. COWEN IS SCIENCE EDITOR OF THE CHRISTIAN SCIENCE MONITOR *AND FORMER PRESIDENT OF THE NATIONAL ASSOCIATION OF SCIENCE WRITERS*

ILLUSTRATION: EUGENE YELCHIN

SCIENCE/SCOPE

NASA's Project Galileo Probe, which will explore the planet Jupiter later this decade, must arrive at a precise angle if it is to carry out its measurements of the chemical composition and physical state of the Jovian atmosphere. The Hughes Aircraft Company-built probe will arrive at 107,000 miles per hour. If the probe hits at too shallow an angle, it will skip off into space; too steep, it will be reduced to ashes. Even at the proper angle, the probe will encounter extremes never before faced by spacecraft. In less than two minutes, much of the forward heat shield will be eroded by temperatures of thousands of degrees. With atmospheric entry forces reaching 360 times the gravitational pull of Earth, the 742-pound probe will take on a weight equal to an empty DC-10 jetliner. Project Galileo is scheduled to be launched from the space shuttle in May 1986 and to arrive at Jupiter in August 1988.

Improvements to a "super cooler" used with infrared sensors in space will extend the life and boost the efficiency of the device. The cooler, vital to defense applications and geological surveys, is a Vuilleumier cycle cryogenic refrigerator. It is designed to chill sensors near absolute zero to increase their sensitivity to thermal radiation. These coolers are ideal for use in space because the low internal forces required by this kind of cooling cycle cause little wear on bearings and seals. Hughes is working under a U.S. Air Force contract to extend the unattended operating life of the cooler beyond five years. The cooler will use less power, so smaller and fewer batteries will be needed to power the device during eclipse periods—a savings of hundreds of pounds.

Significant improvements in infrared simulation technology loom with the development of a device that converts complex visible scenes into infrared images. The device would at first be used for testing missile seekers and other military systems. It converts visible images into infrared by means of a modified silicon liquid-crystal light valve. The Hughes device is being developed to be fully compatible with standard video rates and computer-image generation systems.

In the last 20 years, over $611 million in savings have been negotiated by Hughes and the Department of Defense as a result of engineering proposals for cutting costs of military systems. Since the inception of the Value Engineering program, Hughes has had 675 proposals accepted in 50 programs. The changes stemmed from advanced technology that was not available at the time the original contracts were signed. They resulted in substantial improvements in quality, reliability, producibility, and life-cycle costs. Savings amounted to 3% of Hughes sales during the period, with the U.S. government's share amounting to nearly $500 million. The Value Engineering program is designed to encourage employees to look at the functions of a product and develop alternatives that cost less, perform better, and improve reliability.

Hughes Missile Systems Group, located in Canoga Park, California, an attractive suburb of Los Angeles, is seeking engineers and scientists for such developmental and engineering programs as AMRAAM multimode guidance, Phoenix, and IR Maverick. Openings are in radar and electro-optical systems design, systems software and hardware/software integration, analog and digital circuits design, hybrid process engineering, systems performance, and microwave and power supply/transmitter design. Qualified applicants are assured prompt replies. Please send resume to Hughes Engineering Employment Manager, Dept. S2, Fallbrook at Roscoe, Canoga Park, CA 91304. Equal opportunity employer. U.S. citizenship required.

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LESTER C. THUROW

Jobs versus Productivity: The EuroAmerican Dilemma

SINCE the Renaissance, Westerners have looked to technology to solve their problems. Both Europeans and Americans believe in the technological fix for their current economic difficulties.

Those problems, however, are markedly different. Europeans have been unable to generate new jobs for an expanding labor force. They talk about a technological gap vis-a-vis Japan and the United States, and propose to increase expenditures on civilian research and development as the remedy. Americans, conversely, have been unable to generate a healthy rate of productivity growth. Their remedy: increase expenditure on civilian R&D.

Paradoxically, each is easily able to solve the other's problem. While Europeans have generated no new jobs on a net basis since 1970, the U.S. economy has generated 25 million new jobs during the same period. From 1978 to 1983, U.S. productivity growth was a dismal 0.6 percent per year while European productivity grew at healthy 3 to 4 percent annual rate. Why the difference?

The answer is certainly not to be found in R&D spending. In the 1960s, the United States spent a larger fraction of its gross national product on civilian research and development than European nations. Yet its productivity growth rate was about to start a two-decade decline. In the 1970s, the Europeans expanded their R&D spending while Americans reduced theirs, so by the end of the decade Europe was spending more than the United States. Yet the 1970s were a decade in which the European economy could not create jobs. In the 1980s, U.S. R&D spending has risen, but it is still below the level of major European countries.

The reason for this paradox can be found in the two continents' very different labor markets. Relative to the price of capital, American wages were 37 percent lower in 1983 than in 1972. After correcting for inflation, wages have fallen 6 percent in absolute terms. This has not happened in Europe. The effect of cheaper labor is magnified by the much greater dispersion of wages in the United States.

LESTER C. THUROW IS GORDON Y BILLIARD PROFESSOR OF MANAGEMENT AND ECONOMICS AT THE SLOAN SCHOOL OF MANAGEMENT AT M.I.T.

The worst-paid European makes much more than the worst-paid American.

While the average U.S. wage was $8.01 per hour in 1983, millions of American workers are hired at, or even below, the unenforced legal minimum wage of $3.35 per hour; $4 per hour is common for production workers in high-tech firms with reputations as good employers. Such low-cost, high-quality labor is not available in Europe. The worst-paid European workers make much more relative to the average European than the worst-paid Americans make relative to the average American.

Substituting Robots for Workers

The relative prices of capital and labor invariably influence managers' investment decisions. In Europe, employers tend to substitute capital equipment for workers wherever possible. At last count, for example, Sweden had 13 times as many programmable robots in proportion to the size of its labor force as the United States. Substituting capital for labor—using more robots, for instance—is one principal source of productivity growth.

Yet firms add employees only if their sales volume exceeds their productivity growth. If productivity is growing, the existing labor force, or a smaller labor force, can often fill orders for more goods. So in a situation of slowly increasing sales, good productivity growth leads to bad employment growth.

In the United States, capitalists have received a very different message in the 1970s and 1980s. Workers have become cheap compared with the costs of machinery, so firms have substituted workers for capital equipment wherever possible. As a result, the gains from using robots are not as widespread as in Europe, and firms often find it profitable to move back to more labor-intensive technologies. Because of the resulting lag in productivity growth, a much smaller increase in sales can persuade American firms to add employees. The net result is good employment growth but bad productivity growth.

Europe has been particularly envious of the proliferation of new high-technology firms in Silicon Valley and along Route 128. European governments have responded with subsidies—often in the guise of R&D assistance—for startup businesses, and European leaders are well aware of the need to establish a venture capital industry. But these efforts are unlikely to solve the European problem of creating jobs.

Here again, the different structure of the labor market is at fault. Startup companies have a great advantage in the United States because they can easily fire unneeded employees, be they managers, production engineers, or assembly-line workers. Advance notice need not be given, and severance pay need not be paid. Firms do not need to carry the burden of extra workers if demand is not what was expected. We have recently seen this happen at Atari, which laid off thousands of workers.

In Europe, by contrast, firings are difficult and expensive. Employees, blue-collar or white-collar, must legally be given several months' notice and several months' severance pay. When employers hire labor, they do so with the knowledge that the workers cannot easily be fired. This makes it much riskier and more expensive to go into business. What is a reasonable risk in the United States has become an unreasonable risk in Europe.

But this country pays a price for its labor flexibility. If workers can be fired when-

ILLUSTRATION: BOB DAHM

ever they are not needed, they will reciprocate by quitting whenever a better job comes along. The result is a turnover rate—4 percent per month—that is vastly higher than that found in Europe. Furthermore, with the average firm losing almost half of its labor force every year, and with many high-tech firms having annual turnover rates in excess of 100 percent, no one wants to invest in human skills. Firms know employees are apt to leave before the costs of training can be recouped in higher productivity, and employees know they may soon move to other jobs that require very different skills. The result is a much less well trained labor force.

Lack of trained labor is one of the reasons for the slow death of the American machine-tool industry, for example. When cyclical upturns occur in that industry, U.S. firms do not have enough skilled labor to meet demand. As a result, they lose markets to the Japanese and European machine-tool industries, which do have the needed labor. The U.S. lag in both the use and production of robots may also be traced partly to an unskilled labor force: neither employer nor employee has the incentive to invest in the skills that must be acquired if robots are to be successfully built or used. With much lower turnover rates, Europeans invest more in human skills and gain the benefits of a more highly trained labor force. Accordingly, productivity rises faster than it does here.

Hard Choices

To be successful, every economy must be able to generate both new jobs and a healthy rate of productivity growth. New jobs must be created if unemployment is not to rise continually as workers enter the labor force, and everyone wants the higher standard of living that only higher productivity—more output per hour of work—can bring. This means that both Europe and the United States must find some way to gain the advantages of the other without losing the advantages each now has.

In the United States employers must attempt to produce a better-trained labor force. Lower turnover rates would be a step in that direction, since a more stable labor force produces both the need and the incentive to invest in workers. Many U.S. firms are now moving to win employee loyalty and participation by offer-

Continued on page 79

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BY LEWIS J. PINAULT

The Suffocating Embrace of Japanese Management

I came to Japan with an eye to examining how this accomplished industrial nation could tap the resources of those common spaces now considered beyond national jurisdiction: the oceans, Antarctica, and outer space. I retain a confidence that Japan's productive might and marked energy needs will lead to an industrial policy that can harness these spaces intelligently. But my experience as a full-time employee of one of Japan's leading companies has focused much of my attention on Japan's present-day industrial practices. From what I have seen, the principles of Japanese management have the grace of an all-night study session: they serve to fulfill pressing needs but do so at considerable cost, and are rarely desirable as ends in themselves. That much of the Western media has all but enshrined certain of these principles strikes fear into the hearts of those Japanese workers quite prepared to cast them off.

My company, a large materials and manufacturing enterprise, uses many of the practices heralded by Western business leaders. It offers continuous employment until retirement, a promotion system based on seniority, group decision making, full coverage for health care, and an explicit management ideology stressing intensive participation in company life. However, this pattern of management has produced extraordinary tedium and frustration among many employees.

Continuous employment can excel as a means of strengthening performance. After all, Japanese employees work hundreds of extra hours to diffuse the feeling of obligation this system creates in them. But I usually hear it discussed with little affection. To begin with, companies on a continuous employment system are loathe to hire people who have quit their jobs. As a result, many employees find themselves staying at jobs for which they have neither interest nor training.

"Large companies like ours look at quitting any company as a defect in character," says a 32-year-old sales engineer, whom I shall call Mr. Satoh (all the names in this article have been changed). "Someone who quits one company is considered a high risk, likely to disrupt harmony in the new work environment as well. Hiring another company's man also means absorbing that company's alien ideology."

Satoh says he was ready to quit shortly after he began working for this particular company, but "my responsibilities to my family discouraged me from risking exclusion from the big companies and their more substantial salaries." Large companies offer other advantages as well. "It's good to be associated with a big-name company, for reputation's sake," Satoh notes. "Prestige is no small thing."

The Pressure to Stay Put

According to Mr. Yamazaka, a 30-year-old financial advisor, "almost all Japanese employees think seriously about quitting at some time or other. But there is no guarantee of achieving even the most basic career in a second company." Yamazaka estimates that at least 1 percent, and perhaps as much as 5 percent, of the "lifetime employees" do quit in their first two or three years with a company. The later they quit, he notes, the more they give up of their seniority-based salaries.

By remaining with one company, however, both Yamazaka and Satoh said they had made considerable sacrifices. Notes Satoh: "I've done years of relentlessly dull work in areas completely unrelated to my training." For such employees, the awareness that their skills and interests, no matter how misused at one company, are not welcome at other large Japanese enterprises is a dubious compensation for a long-term guarantee of income.

Group decision making is another practice that sounds good on paper but is less effective in reality. An individual's failure is often graciously forgotten in a group context, which provides a warmth and support that I am not alone in appreciating. But group decision making can impoverish the ability of any one person or group to act with authority. It can also stifle individual ideas and creativity. As Yamazaka notes, "It's important to find and stick with a powerful boss and his clique, moving with him through his career if at all possible. Any idea or proposal, no matter how good it might be, must have the backing of your boss to get any place."

In large Japanese companies, employees are embosomed in a legion of welfare provisions. Company-sponsored housing for bachelors, medical service including a fully staffed hospital, recreation centers, and subsidies for outings and clubs sound very attractive in theory. But in all of this there is a stark absence of alternative lifestyles, calling to mind the austerity and insularity of a military community.

At this particular company site in Kawasaki, hundreds of white-collar workers are each assigned a double room with more bed than floor space. The room is located in a complex that offers a small and usually tepid bath, the most dreary of cafeteria menus (most employees eat out), and a hardy insect population. The city of Kawasaki, a bleak testimony to people's ability to dwell insensate in the thick of chaos, features a climate about as "mild" as that of Washington, D.C. Accordingly, the dormitory's lack of air conditioning is a remarkably effective overtime motivator. Most of the employees I pass in the halls each day seem too beat to notice much of this, but newlywed friends are quick to expound the joys of two-room living.

The company hospital, like most of the Japanese medical system, is admirably accessible. But routine visits must come out of personal holidays, so for most employees it remains a rather abstract benefit reserved for emergency care. Furthermore, many employees are reluctant to use the company facilities because they don't trust the quality of health care. As one former company nurse says, "Health checks here are ridiculously superficial, nothing serious at all: weight and blood pressure, a few thumps here and there, that sort of thing. I found myself arguing more than once with a doctor about a patient requiring more serious attention, especially psychological counseling. But in Japan, mental illness is something shameful, something very difficult to talk about. And the doctors make it worse by insisting that a someone is 'just a little strange' when he's obviously seriously depressed and in need of some professional care."

Company recreation facilities, outings, and clubs can provide warm and enjoyable experiences. But often as not, the mention of a section trip yields groans of resignation, especially from those with family lives; wives and other "outsiders" are not welcome. Such outings often deliver the "coup de grace" to any attempt to maintain a life free of the company's reach.

Management's admonitions and sloga-

LEWIS J. PINAULT is a technology analyst in the planning office of a large Japanese company. He graduated from M.I.T. in 1982 with an S.B. in political science and a concentration in Japanese studies.

Many employees find themselves staying in jobs for which they have neither interest nor training.

neering seem similiarly innocuous. But the pressure to work long hours is quite real and leads me to question the critical faculties of tired and perhaps more pliant minds. The "voluntary" in voluntary extra-hours quality control (QC) groups is a patent fiction, and the English-language PR films that tout it as such bring snickers from some of the management itself. Although QC circles can indeed yield a wealth of cost-saving measures for the company, they exact the price of tens of thousands of wearisome unpaid work hours from employees.

The Cost of Overtime

The amount of overtime worked is perhaps the most profound demonstration of the success and cost of Japanese management control. White-collar males who have not yet attained management rank bear the brunt of it. Although these men are technically limited to 60 hours of overtime a month (and will not be paid for more), many put in this much plus an extra 10 hours or so. At work sites in one-company towns, the scarcity of social alternatives and the desire to get ahead create an environment that leads some men to work 100 hours of overtime per month. "If you want to progress in the company," says Satoh, "you've got to speak and act as if you are close to the heart of the company life, and that means no resistance to overtime."

Mr. Noguchi, a 29 year-old computer analyst, observes, "In tough economic times, people are generally discouraged from reporting more than a third of their overtime. What especially dissatisfies me about this is that the company refuses to officially recognize that this is going on, or how long it's expected to go on."

My particular company recruits men keen to contribute to improved environmental quality. Yet several men have protested to me that it is career suicide to testify against the company in the numerous Kawasaki City pollution suits or to campaign openly for an environmentalist candidate.

"Firing is not a real option for the company, but various pressures are applied: demotions, stifling of promotions, assignment to tedious tasks or distant locations, and cuts in salary are the tangible ones," says Satoh. "Such pressure tactics effectively destroyed the Communist party organization within this company, and formerly admitted Communists are still subject to harassment."

Perhaps women have paid the greatest opportunity costs in Japan's catapult to success. In my company, women perform a plethora of essential but menial tasks at a considerable savings to the company, not only in office automation but also in training (comparatively minimal), education (none at company expense), and wages (50 to 60 percent that of contemporary males). More than 80 percent of these women are personally recommended to the job by friends and relatives, so that any unorthodox behavior carries the risk of damaging the sponsor's career as well.

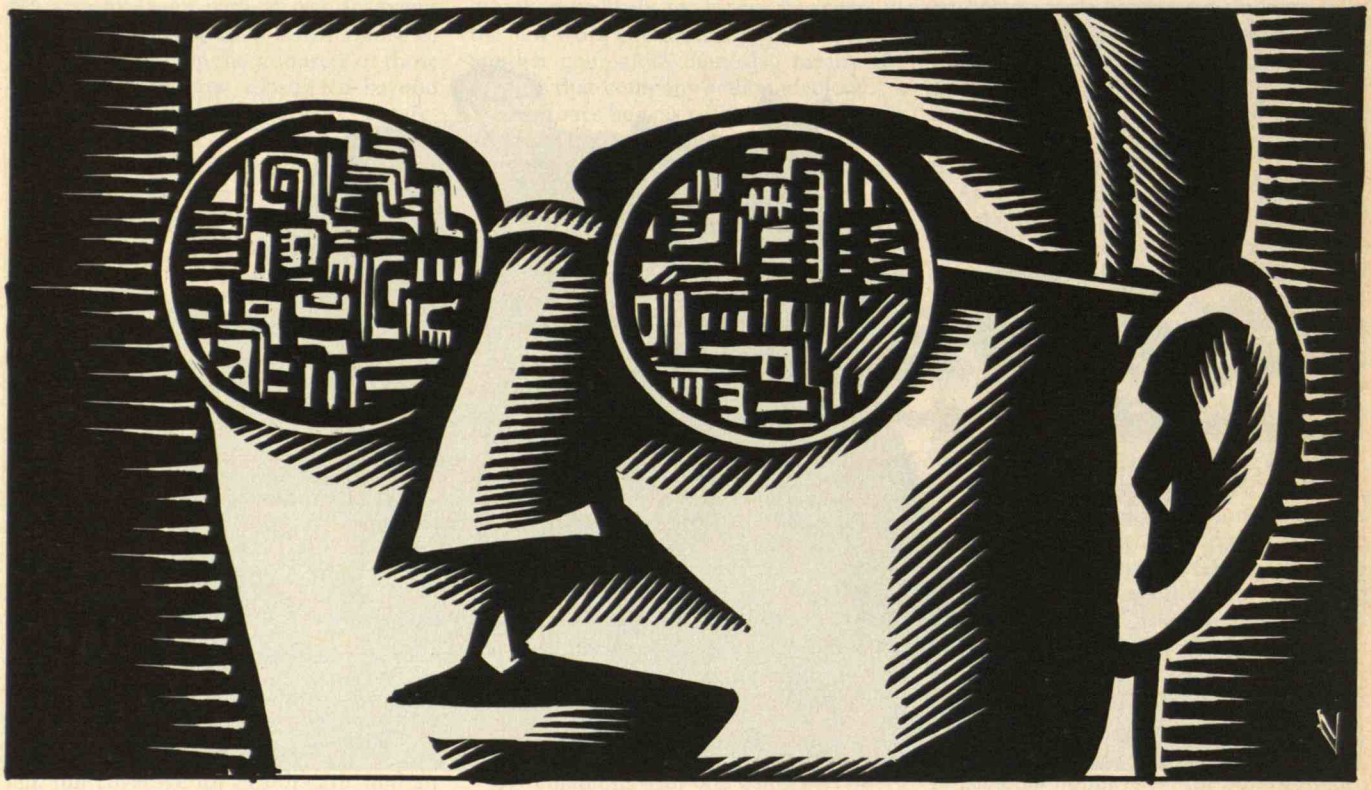
Women employees are also under extreme pressure to marry and quit before age 30. As a 20-year-old female office assistant says, "There's no real career path for us, even if we have a university education. We're expected to get married and leave. Professional interest might get a male the best jobs and a chance to work or study overseas. If you're a woman, it will never get you anything."

Continued on page 64

ILLUSTRATION: ROB COLVIN

BY WIL LEPKOWSKI

The Changing Face of the NSF



ANOTHER of those periodic economic and political hurricanes is shaking the moorings of the National Science Foundation (NSF), the government's premier agency for funding basic academic research. Ten to fifteen years ago, the call was for social relevance. Today it is for meeting the challenge of technological competition—from Japan. Government officials have been worried for more than a decade about Japan's mounting technological prowess, and the evidence remains overwhelming that Japanese corporations continue to draw beads on their American counterparts, particularly in robotics, microelectronics, and materials science.

Faced with this growing challenge, U.S. leaders in business and government are looking to "science and technology" to reclaim our superiority in high technology. Thus the focus on the National Science Foundation, despite the assessment of many experts that this country's lag is not due to any deficiencies in "S&T," but to outmoded methods of management and an emphasis on short-term profits over long-term planning. Somehow NSF—through a vigorous new emphasis on engineering—is expected to provide much of the acceleration needed for the United States to play technological catch-up.

This trend was underscored by IBM chief scientist Lewis M. Branscomb. In his farewell message as chairman of the National Science Board last spring, Branscomb alluded to the foundation's new thrust into research-based engineering: "That NSF should be the chosen instrument for rebuilding engineering education and research may represent a turning point in NSF history," he said.

To provide the inspiration and direction, NSF now has a new director in Erich Bloch, 59, former director for corporate technical personnel at IBM. Bloch is the first pure manager-engineer ever to head the 32-year-old foundation. "He combines more managerial experience than the previous eight directors put together," says one NSF old hand. Bloch is pure high tech, too. And he is now in the midst of fashioning a policy and a managerial strategy for making NSF not just a science but also a technology foundation.

These changes will have a significant effect on the foundation. For most of its history, NSF has defended the concept that science operates best when it operates for its own disinterested self. Despite pressures to dilute that idea, NSF has fought vigorously to preserve it.

According to this tenet, the knowledge produced by American science has driven technology. Now the reverse seems to be true: technology drives science. For example, advances in computer technology now control the speed with which data can be manipulated and thus the pace of science. White House officials are so convinced of this cause-and-effect relationship that they are pressuring NSF to nourish it actively.

Purists versus Pragmatists

In the early 1970s, the agency, under director William D. McElroy, tried to create a program called Research Applied to National Needs (RANN). This program largely succeeded in its attempt to harness scientific expertise to provide a knowledge base for fields such as enzyme engineering and solar energy. But the purists at the NSF were determined to kill RANN, not only because it took funding away from

WIL LEPKOWSKI is a senior editor of Chemical and Engineering News.

ILLUSTRATION: ANTHONY RUSSO

The new shape of the foundation raises some questions about how science should be used in a democratic society.

their pet projects, but because it abused their notion of basic science. By 1977 the program's existence had created a climate so venomous that director Richard C. Atkinson decided to wipe it out.

Seven years later we have Bloch's NSF, which is attempting to institute something that might be called RAIN—research applied to industrial needs. Basically the NSF is establishing a new program to support biotechnology research and several interdisciplinary engineering research centers. The latter will be devoted to crucial industrial areas such as light-wave technology, intelligent robotic systems, factory automation, heat-transfer technology, and steelmaking. Undoubtedly there is more to come as NSF's budget soars beyond its present $1.5 billion.

RAIN has encountered little opposition thus far, probably because directed science is now "in" politically. Still, RANN haunts the administrators who are trying to make a go of RAIN. The despised former program has never been given a respectful internment, much less an objective post mortem.

The question today is: should NSF exist to serve industry by funding applied research? Wouldn't creating a new federal entity to manage policies and programs directed toward technology be more appropriate? NSF may always fulfill purposes that go beyond basic research, such as supporting earthquake research, polar studies, policy studies, minority and handicapped students, and administration of international research agreements. But when it comes to functioning as some sort of funding agency on behalf of industry, that may be pushing NSF a bit too far. The administration has already tapped national laboratories such as Oak Ridge and Brookhaven for that purpose. When is enough enough?

Perhaps a wholly new technological agency does need to be formed in Washington. Technology and all it entails has gotten very big indeed, and its presence in the National Science Foundation could in the end dilute the foundation's purpose, as engineers vie with scientists for control of the agency's priorities. For three years, Rep. George Brown (D-Calif.) has introduced bills calling for a National Technology Foundation, which would centralize government support for development of new technology. Brown hasn't given up on the idea despite opposition from the scientific community.

There are good and valid reasons for scientists to insist that Washington support pure science in no context but its own. If that means limiting NSF to funding the best science there is and developing scientific talent throughout the country, then small it should be.

The new shape of the foundation also raises some questions about how science should be used in a democratic society. These questions are important because social criticism has quieted during the past four years—a time in which technology has spread like a vast fog over people's lives and the country's institutions. Federal research relevant to problems of industry is a big theme in Washington today. But no one in official places seems to be asking questions such as whether the festooning of electronic gadgetry on automobiles will really benefit drivers, or whether the food-stamp program could be oriented to guarantee healthy diets for its recipients. Or further, whether more funding for soil conservation is needed in an era when agribusiness has done almost nothing to stem erosion.

These are the types of questions RANN asked the 1970s. While NSF may not be the place to pursue industrial applications, it should encourage scholarly inquiry into the ways technology could be used to spur economic and human development. Today's political climate discourages such inquiries, yet they are precisely the type of broad "science, technology, and society" questions that are of most concern in this technological age. The utilitarian probusiness policy now operating in Washington today is shortsighted at best.

We should establish a national foundation to experiment with ways to reinvigorate technology in the United States. But we should leave to the NSF the mandate to support free inquiry in any direction the mind and conscience lead. □

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Insights into Two Careers

Intuitive Architecture

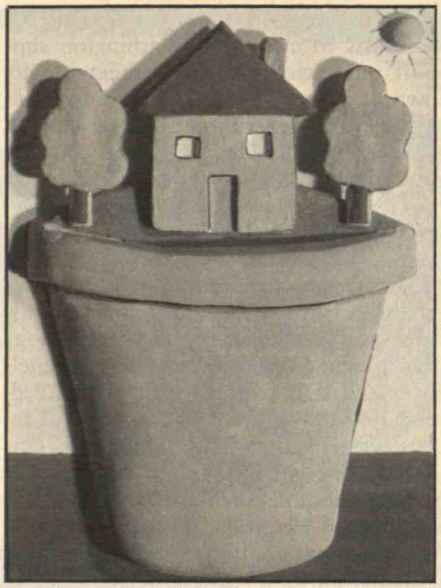
Christopher Alexander: The Search for a New Paradigm in Architecture
by Stephen Grabow
Oriel Press, $30

Reviewed by Robert Campbell

Depending on one's point of view, Christopher Alexander, one of the world's best-known architectural theorists and a professor of architecture at the University of California at Berkeley, is either one of the great seminal thinkers in the field today or a funky, eccentric holdover from the sixties. Alexander maintains that ordinary people design the world better than technicians and experts; that the small detail, the patch of sunlight on the breakfast table, is more important than the large abstract plan; that things must be made hands-on, with joy, if they are to be made well; and that intuition should be trusted ahead of reason. He is either a kind of dotty English gardener, puttering about, or a prophet of a crucially needed, more humane relationship among designers, society, and the built world.

In almost no American schools of architecture is Alexander's vision (for it is nothing if not a vision, holistic and ambitious) an important presence. This is partly because he has no interest in the history of architectural styles and forms, an omission that separates him from the occupants of the salons of Postmodernism. Nor does he care about connecting architecture with the hard-nosed "real world," whether defined as that of bankers and computers, solar energy and ecological responsibility, or social research and political advocacy.

This difficulty in categorizing Alexander is one reason he has been less influential than he might have been. Another reason is his self-regard. Like Thoreau, Alexander marches to a different drummer with a kind of open-shirted, holy-man persona that can be irritating, and like Thoreau he expresses himself skillfully but sometimes smugly. The smugness is inevitable because Alexander is an intuitive Platonist: he believes there are larger truths, or one larger truth, behind the world we see, and that this truth can be ascertained by direct perception—his own. He therefore seeks absolute principles for architecture, but



they are never abstract, coming usually in the form of zenlike recommendations for a window seat, a bend in the path, an ornamental border, a more joyous group experience on the building site.

Humanizing Architecture

Alexander begins with an emotional and powerful reaction against the world as we are building it today, which he finds alienating and ugly. Although he himself started out as a scientist and mathematician, he believes that pseudo-scientific analysis has made today's architecture unattractive because it has substituted abstract concepts for living perceptions. Thus, instead of being constrained by central financing, contracting, planning, and design, says Alexander, we should build with our own hands the places that will be for our own use, modifying them continually as one might expect to modify and adapt a garden. To have beautiful architecture we should design on the site while we build, without drawings as far as possible, responding to each new condition as we create it.

It's probably time I stated my own view, which is that Alexander is an undervalued and truly significant thinker. His willingness to rely on his own intuition is, I believe, a much more candid position than the pretence of rationalization put forward by many lesser intellects. You feel you are able to engage him as another person, and that you are both very far from that world of supposed objectivity that has dehumanized architecture in our century. Indeed, a belief in the value of intuitive perception has been creeping back into architecture for some time. Proponents of the Postmodern movement understand, for example, that people perceive buildings and building parts as analogies of their own bodies and families, of natural and landscape forms, and of the cosmos.

Platonic Patterns

Alexander makes his most important contribution in the book *A Pattern Language*, in which he and his colleagues try to determine why some rooms, some villages, some gardens are a joy to experience while others are not. Alexander analyzes hundreds of photographs of wonderful places, from every architectural era and culture, to determine what accounts for their success. He then encapsulates his insights about each place into a prescription—a Platonic "pattern"—that, if applied, will give us good architecture.

The patterns are often poetically named: Child Caves, Half-Open Wall, Window Place, Zen View, Small Panes. In discussing this last pattern, for example, Alexander recounts how proponents of the Modern movement could see no logical reason why large windows should be divided into smaller panes. They therefore created the window wall—a single vast sheet of glass. However, Alexander finds that, logical or not, small panes feel better. If this process seems intuitive, I can only submit that I, at least, find almost all Alexander's special places beautiful and his patterns convincing. His insights are unforgettable because they legitimize one's own experience.

The attempt by Alexander and others to apply these patterns in actual buildings has been less successful. Aglomerating many patterns, they have found, does not necessarily create a good building: the result often lacks an overall ordering concept. Thus, Alexander has undertaken a further quest, verging on the religious, for deeper patterns of order, a quest that is still in progress.

Stephen Grabow, the author of this study of Alexander, is director of architecture at the University of Kansas. The value of his book, which is considerable, lies almost entirely in the numerous, often generous quotations from his many interviews with Alexander. The architect is al-

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"Because of his color, he was unable to enter the larger universities in the country."

ways present and alive in his own words, always eloquent, always saying things with the freshness and precision that come when one is saying them for the first time.

Grabow's own contributions to the book, unfortunately, are of much less interest. Most of his text merely paraphrases what Alexander has just said or is about to say much better. Grabow also attempts, irrelevantly and repetitively, to interpret Alexander's place in the history of architecture in light of the theories of scientific historian Thomas Kuhn. Grabow is adulatory and uncritical, his writing is as conventional as that of an annual report, and the book is riddled with typos and minor grammatical lapses. However, as the quotations from Alexander are in italics, the reader can skim over the Roman and concentrate on Alexander's own words. □

ROBERT CAMPBELL is architecture critic for the Boston Globe *and a practicing architect in Cambridge, Mass.*

Black in a "White" Profession

Black Apollo of Science: The Life of Ernest Everett Just
by Kenneth R. Manning
Oxford University Press, $29.95

Reviewed by Robert K. Weatherall

Who was E.E. Just? An old Woods Hole photo, circa 1919, shows a group of biologists having a bull session on the grass. The caption identifies one scientist as future Nobel laureate Thomas Hunt Morgan. Another, with close-cropped curly hair, is identified as Just, "a brilliant embryologist from Howard University."

I first came across Just's name while researching the history of postdoctoral fellowships. In 1919 the National Research Council, the executive arm of the National Academy of Sciences, began awarding such fellowships to spare young scientists the burden of routine teaching and to give them the stimulus of working at a research-oriented university. The council report on the program noted that a special grant was awarded in 1920 to Dr. Ernest Everett Just to support his work at Howard. "Because of his color," the council stated, "he was unable to enter the larger universities in the country."

This theme of opportunities closed because of color and despite brilliance recurs throughout Manning's book, as it must in biographies of so many black Americans. It is, of course, one reason for today's interest in the life and times of Ernest Just. Out of the dusty records, Kenneth Manning, associate professor of history at M.I.T., has pulled together a vivid account of the man and his career.

Just grew up in Charleston, S.C., where his mother supported her children through a variety of jobs. She sent him to nearby South Carolina College when he was only 13, and then to Kimball Union Academy in Meriden, N.H., where he was a prize student. This success led him to Dartmouth, where he majored in biology and was the only member of his class to graduate *magna cum laude*. Because Just considered himself a scholar, he was determined to work at a university and not simply teach high school—the route for many black college graduates of his day. As no white university would hire him, he obtained a job as an English instructor at Howard University in Washington, D.C., where he later became an assistant professor of biology.

When Just began to consider continuing his education in biology, he contacted Frank R. Lillie, head of the Zoology Department at Chicago and director of the Marine Biological Laboratory at Woods Hole. Lillie invited him to take courses and become his research assistant at Woods Hole during the summer, an association that was to influence Just's entire career. Just earned a doctorate under Lillie at Chicago and adopted his biological specialty, becoming an authority on the fertilization of the egg cells of mollusks and sea worms. (He did not choose this subject on a whim. Marine animals do scientists the favor of releasing their millions of eggs and sperm into the water, where the reproduction process can be readily observed. Study of these cells has therefore led to many advances in cytology.)

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Just's first summers at Woods Hole were exhilarating. But as his scientific reputation grew, it galled him that his white colleagues could spend the rest of the year at institutions such as Michigan, Columbia, and Caltech while the only place for him was Howard. The other scientists seemed to accept this situation as a given—never mind that Howard had little interest in research and taught science only up to the master's level. The foundations to which just looked for support were of little help. Eager as they were to improve the quality of education and research, they failed to use their leverage to force institutions to hire black scientists. One foundation even argued that Just should stay at Howard "for the sake of his race." Clearly, only external pressure by government could change this situation.

Discrimination against women was every bit as blatant. In 1924, Karl Taylor Compton could not persuade any coed university in the country to hire Jane Dewey, who held a Ph.D. from M.I.T. and had worked under him at Princeton and Niels Bohr in Copenhagen. Fortunately, Bryn Mawr recognized her qualifications and hired her.

Just's plight caught the attention of the left-leaning biologist Jacques Loeb, but he gave Just no concrete encouragement. Indeed, after Just published critiques of Loeb's ideas on fertilization, Loeb recommended that he teach high school. Although other scientists assured Just of the value of his work, even those in the Woods Hole community treated him as an outsider. Just had been married more than a dozen years before he dared to bring his own family to Woods Hole. When he finally did, his wife saw quickly that she was not welcome and took herself and the children back to Washington.

In 1929 Just received a grant to spend six months at the Zoological Station in Naples, and the following year he became a guest professor at the Kaiser Wilhelm Institut in Berlin. He returned to Woods Hole only once, to celebrate Lillie's sixtieth birthday, telling his old friends at Woods Hole, "I have received more in the way of fraternity and assistance in . . . one year at the Kaiser Wilhelm Institut than in all my other years at Woods Hole put together." Just returned to the United States when the Nazis overran Europe, but he soon died of cancer.

Because Just was never allowed to compete for jobs with white scientists, ranking him as a scientist is difficult. Just himself did not know how high up the academic ladder he could have gone. His scientific instincts, like those of his mentor Lillie, were conservative. During Just's first year at Woods Hole, Thomas Hunt Morgan and his co-workers at Columbia published their landmark book *The Mechanism of Mendelian Heredity*. These scientists proposed that the structure and organization of chromosomes determine the transmission of hereditary traits. By cross-breeding different strains of fruit flies, Morgan's group was able to suggest the location of specific genetic material in the chromosomes, laying the groundwork for other scientists to isolate the gene itself.

Yet Just sided with the old guard rather than with the revolutionaries, continuing his research on mollusks rather than experimenting with other life forms. Perhaps he was too isolated from the biologists conducting the groundbreaking research to participate. Perhaps he was too close to Lillie, who, although elected president of the National Academy of Sciences, is not considered a major figure in twentieth-century biology. Just was also a naturalist, put off by scientists who thought that physics and chemistry could explain the

Continued on page 79

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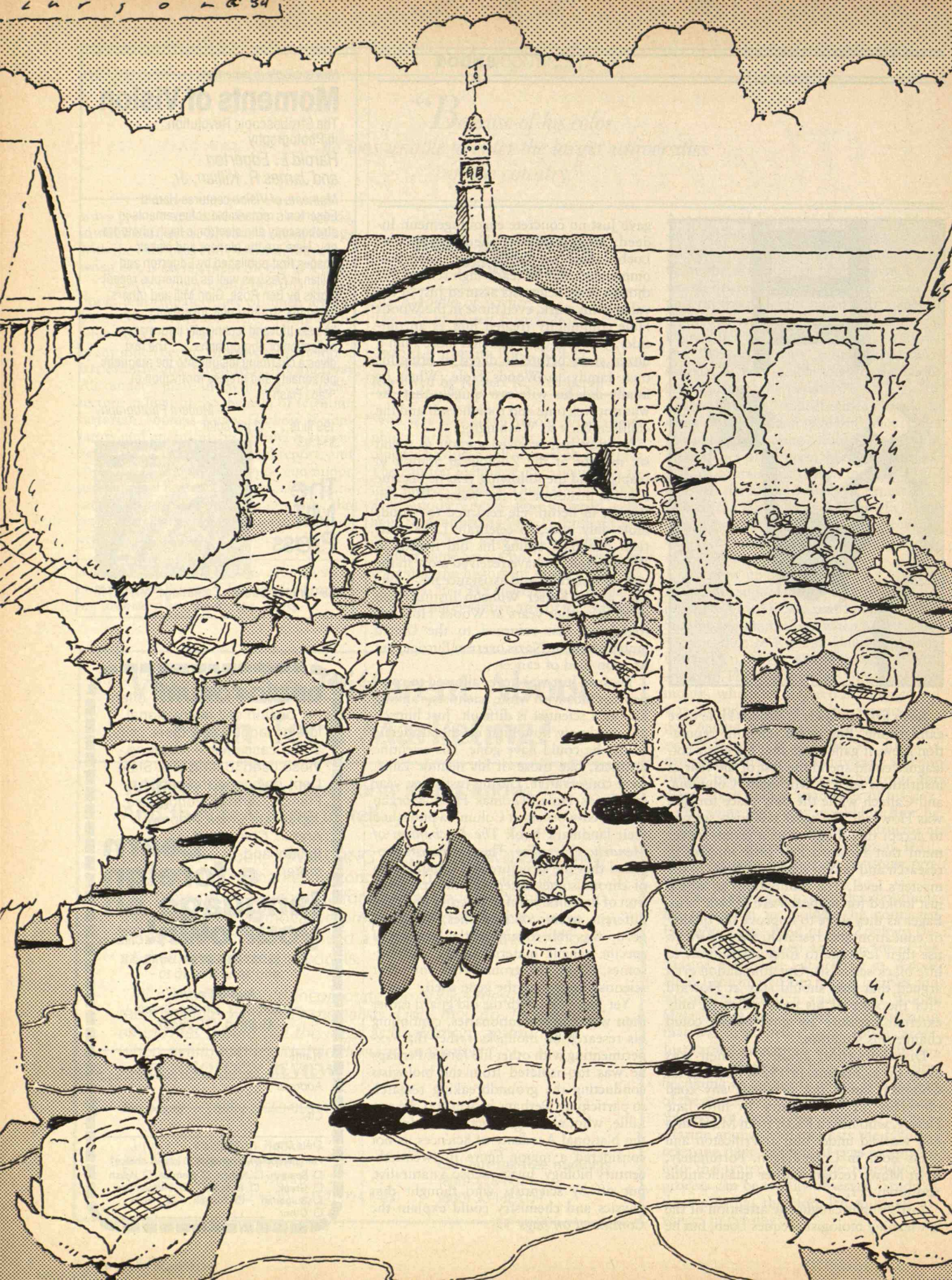


Computers Are Sprouting in the Groves of Academe

BY PETER GWYNNE

THE 780 first-year students entering Harvard Business School this semester need more than text books and sharp wits to help them through their arduous course-work. For the first time, school authorities expect them to use IBM personal computers—purchasable at a discount through the school—as part of their preparation for classes. "We are strongly urging every one of our first-year students to acquire a machine," said Professor F. Warren McFarlan, chairman of the first-year M.B.A. program.

Last June, Digital Equipment Corp. and the University of Houston announced a joint plan to establish the nation's largest network of computers on any college campus. With a $35 million grant from Digital, the university will start work on a network that will eventually link as many as 20,000 computers in the school's four campuses and the homes of its students, 91 percent of whom commute to class. The system, said university President Charles E. Bishop, "will enhance virtually every aspect of the university's instructional and research programs." Added University Park campus Chancellor Richard L. Van Horn: "We want students to be able to use computers effectively without knowing a great deal about computers."

Early this year, before it launched its Macintosh personal computer, the Apple Corp. formed what it calls the Macintosh Consortium. The group will allow students at more than 20 universities to buy their own Macintoshes at bargain-basement price tags of $1,000—about 60 percent below the normal retail price. Dartmouth College, Drexel University, and the University of Michigan have already agreed to purchase about 6,000 of the machines over the next three years. Researchers at universities in the group will develop educational software for the Macintosh.

About 500 students at M.I.T. are acting as pioneers this semester in Project Athena. They are taking the first courses offered through the $70 million experimental project. Named for the Greek goddess of wisdom, Athena aims to make computers and computing facilities available to every individual on the campus. As a unique feature, it is using hardware

Computers are becoming a routine part of the educational process on a growing number of campuses. But fundamental questions must still be answered about their influence on the way in which knowledge is taught and learned.

ILLUSTRATIONS: JIM CARSON

from both IBM and Digital on the same network, and undertaking a major research effort to make the two companies' products compatible. "We are trying to install as generic a facility as possible," explains Professor Steven R. Lerman, who heads the project.

Computers, plainly, are coming to the campus in profusion. And unlike the situation only two or three years ago, the machines aren't there just to help the high-fliers in engineering and science. Major liberal arts institutions such as Brown and Dartmouth are adapting their networks of linked microcomputers to the task of teaching humanities courses, from introductory French to the works of Dante. Even small liberal arts colleges, such as tiny Union College in Nebraska, are installing their own systems that give students access to terminals. The time is clearly approaching when college admissions officers will boast about their proportions of computers to students as readily as they now quote faculty-student ratios.

To its proponents, the on-campus revolution in microcomputers opens up a whole new world of opportunity in higher education. If all goes well, students of coming decades will accept computers as readily and routinely as they accept textbooks—themselves a startling invention of the late 18th century. "The computer is the most significant addition of capital to students since the printing press," according to Carnegie-Mellon University President Richard M. Cyert.

Critics aren't so sure. They worry that the growing use of extensive computer networks might irreversibly skew the whole process of higher education, emphasizing technological subjects that clearly benefit from computers at the expense of disciplines in the liberal arts that do not readily translate into the codes and symbols of modern software. Some scholars also express the fear that increasingly powerful computer technology at ever more attractive prices will replace human teachers—even though, as Stanford University philosopher Patrick Suppes puts it, "we need our charismatic lecturers."

Other vague concerns are mulled over in department offices. One focuses on the companies that wire up the campuses—IBM, Digital, Apple, and their competitors; might they overcommercialize their operations, forcing colleges to select high-profit items that don't really fill their educational needs? Another worry stems from the strong possibility that computerization will create a new elite among colleges. Prestigious institutions that can afford to install networks of work stations and other terminals will almost certainly increase their attractiveness to the best students, in comparison with poorer colleges that cannot afford, or do not fully understand, the new technology.

Proponents and critics of the computerized campus agree on one fact. Once they arrive in large numbers, microcomputers will fundamentally change the nature of higher education, even though that change may not become apparent for several years. "The educational market is exploding," asserts Sam Fuller of Digital. "Nobody has the luxury to digest the lessson before pushing on. The challenge is how to do it in a responsible way."

The Technological Base

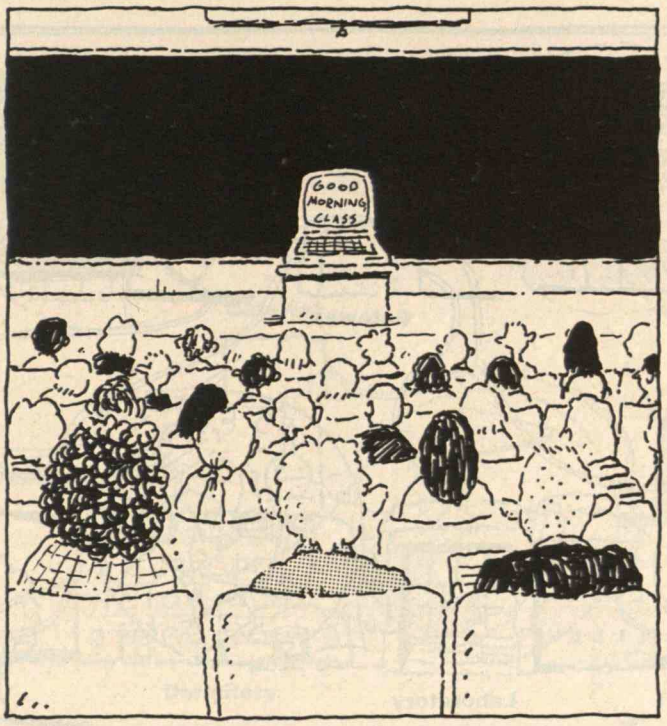
Until recent years, educational computers took one of two forms, each equally unsatisfactory from the point of view of most college students. On the one hand, "skill and drill" learning machines provided high school students with passive, inflexible instruction in limited subject areas. U.S. Secretary of Education Terrel H. Bell, among others, has denounced such use of computers in education as an ineffective fad. At the other end of the scale, timesharing bought the capabilities of large mainframe computers to several would-be users around any particular campus. The disadvantage here was that of accessibility. Tapping into a timesharing network required knowledge of computer languages and programming far in excess of that available to the average undergraduate. As a result, the use of such systems has been largely restricted to students majoring in the hard sciences and engineering.

The advent of microcomputers has changed all that. They are designed to be user-friendly; customers don't need a complex course of instruction to be able to use them. They have the ability to reproduce tables of figures, charts, and even concise graphics on their screens. And when linked in a distributed network, the microcomputers give their users access to as much computing power as the time-shared mainframes of a decade ago. "Our goal, wherever practical, is to enable any student or faculty member anywhere on campus to reach into any library, classroom, computer, or laboratory at the touch of a finger," explained Wesley W. Posvar, chancellor of the University of Pittsburgh, which re-

Once they arrive in large numbers, microcomputers will fundamentally change the nature of higher education.

cently announced its plans for a campus computer network.

No two colleges have organized their networks in identical fashion. However, most facilities have several factors in common. Thus it's possible to piece together a "generic" college computer network, based loosely on M.I.T.'s Project Athena.



The spine of the network is a fiber-optic cable that winds across the campus, carrying electronic signals in the form of light pulses at ultrahigh speeds. Linked to the spine, through a series of electronic black boxes known as gateways, are various "local-area networks." These are clusters of perhaps two dozen desk-top computers, or work stations, operated by users of the network. Each local area network also contains a "file-server"—a device in a temperature-controlled clean room that looks like a microcomputer with two disk drives—to store long-term data for the local network. Because of the nature of information processing, the file-server is not necessarily located in the same place as its local area network, even though it is connected to it in a computer-logic sense. The individual work stations in each local area network are placed around the campus, in laboratories, faculty members' offices, dormitories, and other areas in which potential users congregate.

Other basic systems can link up to the fiber-optic spine through gateways. They include the library and the network's user identification system. The former provides just the same services that any conventional college library fulfills, but in digitized form. The latter checks the credentials of the network's users as they come on line. In some colleges, more specialized services might link up to the spine through their own gateways. A mainframe computer, for example, can give the system more number-crunching power than it would otherwise possess. And a computer research laboratory can serve to experiment with ways of boosting the network's capabilities.

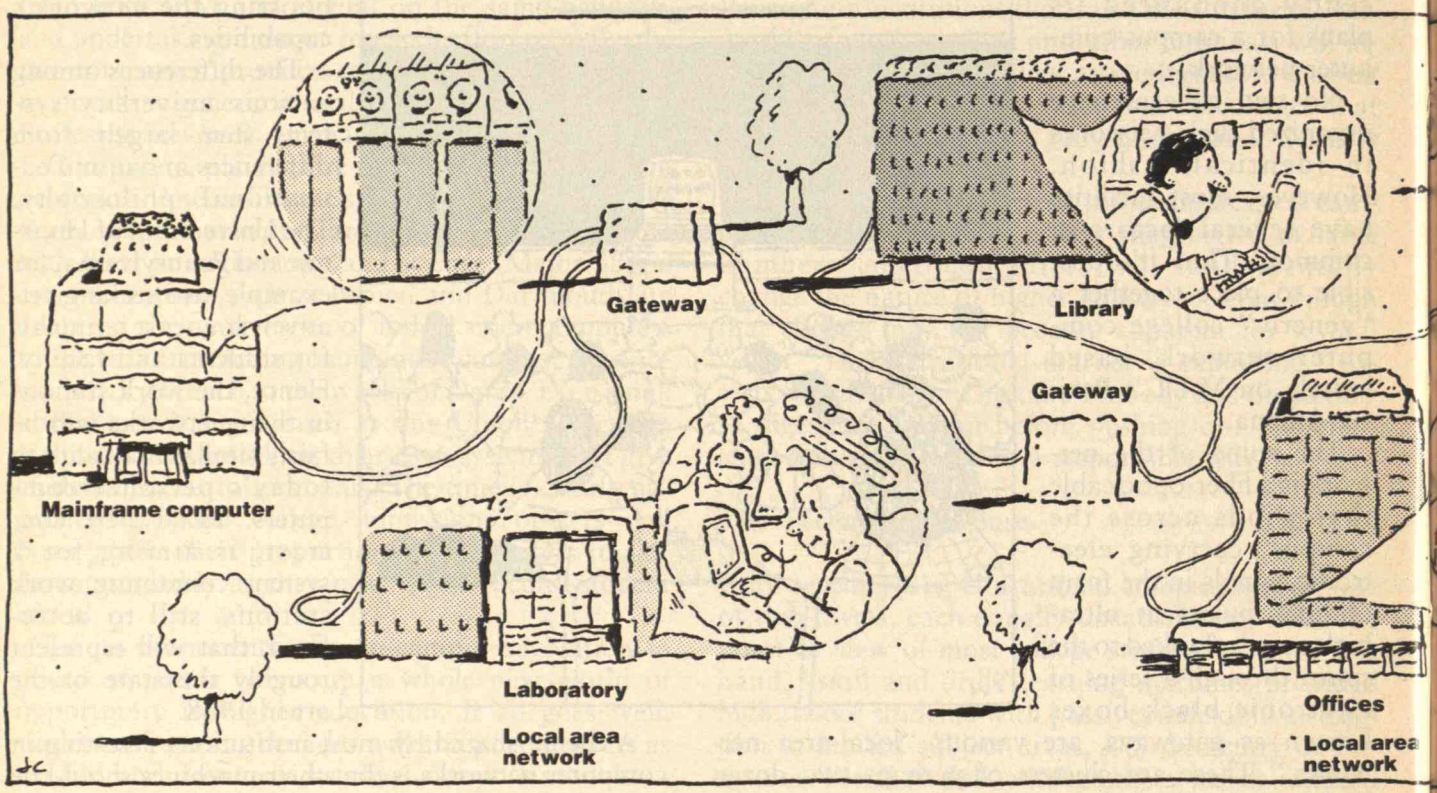
The differences among various university systems stem largely from differences in size and educational philosophy. The Universities of Houston and Pennsylvania, for example, are seeking relatively low-cost terminals for students and faculty. Hence, the work stations in their networks will be fairly similar in quality to today's personal computers. M.I.T., by contrast, is aiming for a system containing work stations, still to be refined, that will represent roughly the state of the art in 1988.

A theme shared by most institutions investing in computer networks is that their machines should be "invisible" to students, requiring no special ability in, or feel for, programming and other minutiae of the computer professionals. "Using the work stations should be like using the phone," declares M.I.T.'s Lerman.

Making the Machines Invisible

In practice, computer invisibility will mean that users can plug into a network using any brand of personal computer or work station. That's a utopian dream at present, but M.I.T.'s Project Athena is tackling the problem by using machines—and technical advice—from IBM and Digital, and attempting to achieve coherence between the two companies' products.

The merger won't be easy. The differences emerge even at the level of the local area networks. IBM's are put together in circular fashion, while Digital's are wired linearly. Exchanging information between IBM and Digital terminals will demand plenty of electronic action inside the network. A request from a Digital terminal, for example, will move up to the nearest gateway, where it will be translated into a "protocol" common to the system as a whole. Then



it will speed along the spine to the gateway that opens up on the local network containing the target IBM machine, where it will be re-translated into symbolism that the IBM machine can understand.

The problem of incoherence also applies to software. At present, users must learn how to use each package. Communicating across the barriers between different computer languages is extraordinarily difficult. Ideally, Athena's managers would like to use a single language for the whole system; however, the diversity of specialized needs is so great that this isn't possible at present. So the group has selected four languages: LISP, which basically manipulates symbols; FORTRAN, for number-crunching; C, which serves signal processing; and PASCAL, which teaches the methodology of programming. In addition, Athena personnel have chosen a single operating system, known as the Unix 4.2, to serve as the traffic director for the signals rushing hither and thither throughout the network. As the system stands at present, says Lerman, its four languages are standardized. However, it may become necessary to modify them to fulfill the goal that any user be able to use any program on any work station in the network.

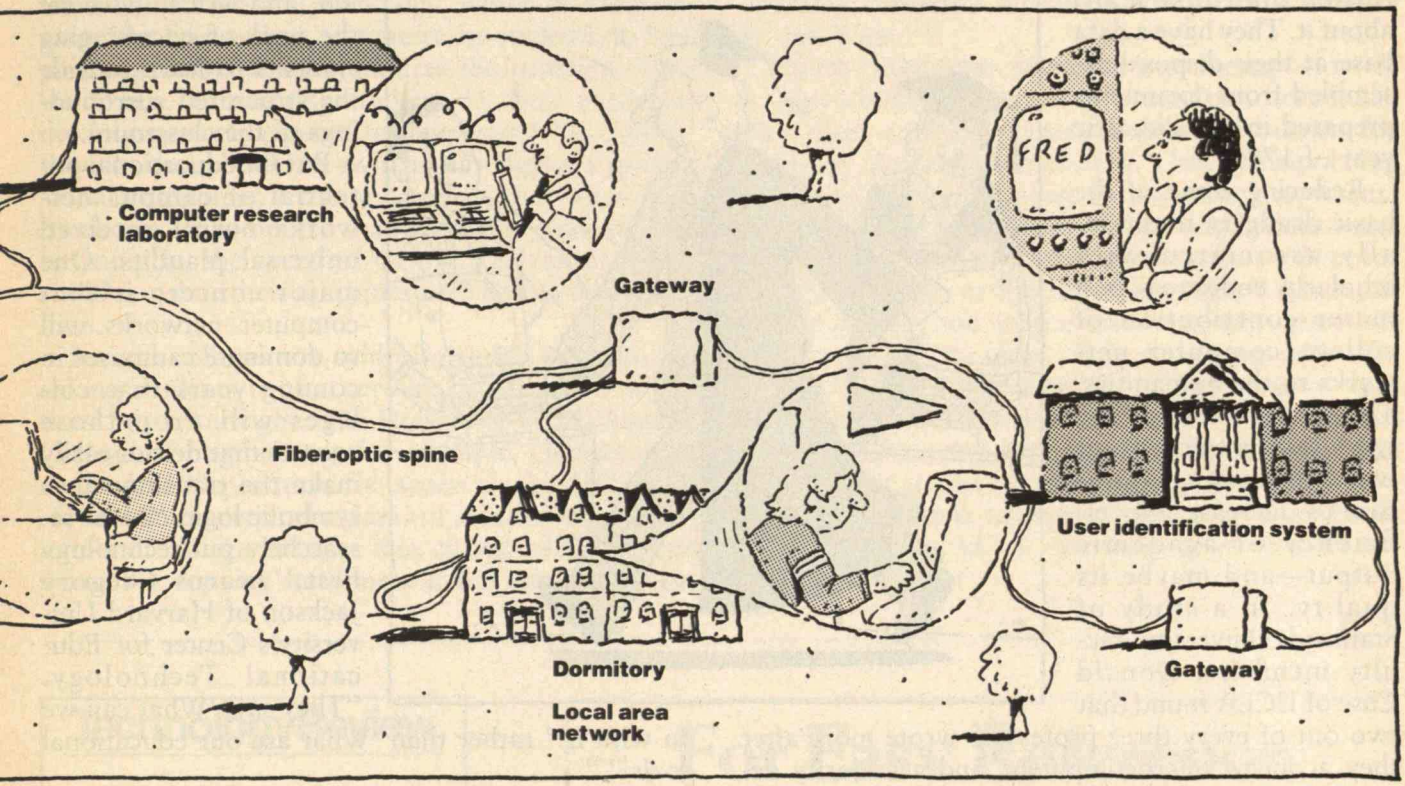
Educational Pluses and Minuses

Technology represents just one critical factor in the educational computer equation. Far more important to many faculty members devising distributed campus networks is the issue of their systems' educational value. Will the networks teach students adequately? Will they make available at least as wide a curriculum as human teachers now offer? And will they switch students on to the specific subjects rather than turning them off?

Departments in engineering, computer science, and the physical sciences have taken to the distributed networks readily. That's not surprising. Students in those disciplines can obviously benefit from the type of symbolism and the number-crunching power that the networks provide. Further they have, for several years, expected to work with computers in their professional lives. But the networks can now give such students far more than a calculating capacity far exceeding that of hand-held calculators.

One major function of a network is to act as a "virtual laboratory"—in which student can carry out imaginary experiments that are either difficult

The ability of any work station to carry out word processing promises to increase the efficiency of academic output.

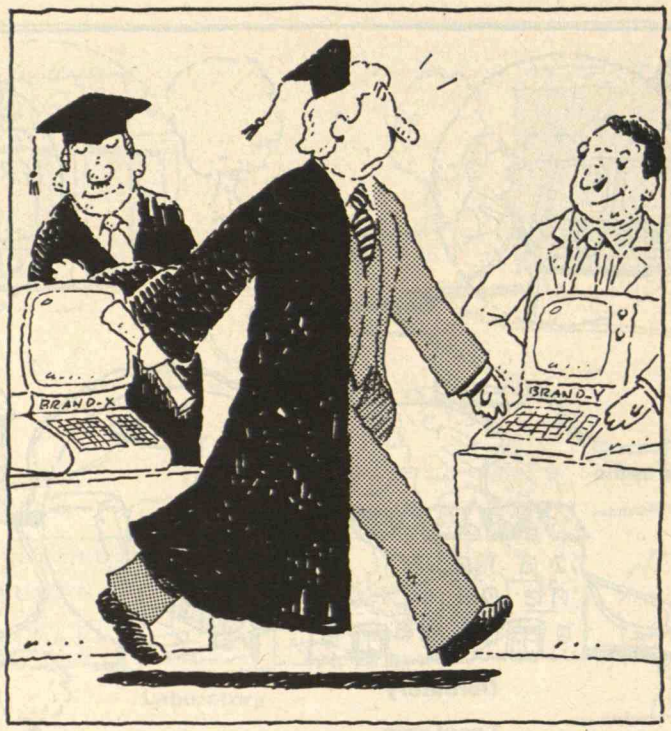


or impossible to do in the real world. Few universities have nuclear reactors available on campus, for example, and even fewer would allow undergraduates to experiment with them in any realistic manner. But with appropriate course software, students in nuclear engineering can be exposed to simulated situations that test and stretch their knowledge. Similarly, it's difficult for engineering departments to develop the real breakdowns of equipment that are necessary to teach fledgling engineers the skill of trouble-shooting. But computer programs can present trouble-shooters with just about every situation that they might meet on the job.

Simulation isn't restricted to engineering and hard science. Business schools at Harvard, Carnegie-Mellon, and the University of California, Los Angeles, among others, ask their students to play what's known as a management game. Sitting at the work station, the student confronts a simulated company that he or she must operate in light of changing economic, political, and cultural variables. At Dartmouth College, geography professor Robert E. Huke has devised a program that simulates the situation facing a rice farmer in the Philippines. Students use their microprocessors to adjust up to 26 different variables, such as seed variety and weather conditions, in order to maximize their yield and profit. Then, in the middle of their operation, they must take account of a land reform plan simulating the one recently introduced by Philippine President Ferdinand Marcos.

Computer networks also offer creative outlets to at least some humanities majors. The drill master character of old-style computer-aided instruction, combined with the flexibility of modern distributed networks, make a natural combination for teaching foreign languages. In August, M.I.T.'s Athena project received a grant of $1.3 million to develop a curriculum for teaching a range of languages at the elementary level. Professors at Dartmouth are computerizing 125 commentaries on Dante's *Divine Comedy*. Physically, the commentaries are spread out in museums around the world. But electronically, they will be available to any student with permission to enter the Dartmouth network—a factor that will undoubtedly encourage in-depth research. Similarly, students taking a course on the French Revolution at Carnegie-Mellon have the chance to do history

Some college administrators fear that the human element of teaching will be lost.



rather than just learn about it. They have a data base at their disposal assembled from documents prepared in the climactic year of 1789.

Reducing some of the basic drudgery traditionally associated with scholarly endeavors is a major contribution of college computer networks to the humanities. The simple ability of any work station to carry out word processing promises to increase the efficiency of academic output—and maybe its quality. In a study of Stanford University faculty members, Donald Case of UCLA found that two out of every three professors wrote more after they acquired microcomputers, and a majority expressed the belief that the quality of their work had improved. Students facing all-nighters to complete tough term papers should gain at least as much benefit. "How many papers have stopped right where they were because in order to redo them you had to start again?" asks M.I.T. Chairman David Saxon. "Now, that's no longer necessary."

Personal computers linked up in networks offer advantages to students on both sides of the academic mean. At Carnegie-Mellon, for example, faculty members are developing a computerized safety net for freshmen who have problems with basic English. Once the system is integrated into the network, instructors who detect problems in students' written papers will send the students to an electronic skills center. There, they will receive remedial disks or tapes, on which they will work in their own time while continuing with their normal load of class work. Ideally, the system will reduce the number of students who drop out of required first-year courses because of inadequate high-school prepartion.

At the other end of the scale, the networks should give students the flexibility to move ahead at their own pace in subjects that they master quickly. Faculty developing programs at Brown, Carnegie-Mellon, and M.I.T. have set the goal of encouraging students to learn outside the structured surroundings of the classroom.

But the educational potential of campus networks hasn't received universal plaudits. One major concern is that computer networks will so dominate campuses in coming years that colleges will drop those courses that do not easily make the transition into symbolic logic. "Most researchers put technology first," warns Gregory Jackson of Harvard University's Center for Educational Technology. "They say, 'What can we do with it?' rather than 'What are our educational goals?' "

If specific courses can drop by the wayside on newly-computerized campuses, so can students who just don't feel comfortable with work stations and the electronic aura of networks. Some college administrators fear that the human element of teaching—the interplay during and after lectures—will be lost as inspired teachers spend their time writing teaching programs rather than standing up in person to present lectures.

Even simulation exercises have a down side. If overdone, they may teach engineering students a bloodless approach to their craft—denying them the opportunity to pick up the intuitive feel for engineering that comes with real-life laboratory and field work. "You must limit what's done in simulated laboratories," agrees M.I.T.'s Lerman. "You can't have the simulated lab displace the real one."

Obsolescence and Elitism

Students may face a commercial problem. Will they be able to recoup the few hundred, or few thousand, dollars invested in a personal computer for college at a time in which rapid obsolescence is as inevitable as death and taxes? The experience of New Jersey's

Stevens Institute of Technology, which in 1982 became the first college to require its students to buy personal computers, crystallizes the problem. Two years ago, 80 entering students in three academic disciplines were required to buy Atari 800s. Today, though, the school has switched to Digital's professional computers. Even in a college that stays with its choice of computer manufacturer, students can be stung by the speed of technical advance, which could out-date their machines even before they graduate.

Several colleges are addressing this problem by asking students to rent terminal equipment, rather than buy it outright. The University of Michigan's College of Engineering, for example, charges each student $100 per term for access to the 600 work stations in its network. Harvard is following the example of college libraries that charge small fees for using the copying machines: It has installed coin-operated computer terminals, for which it charges $2 per hour.

Plainly, computer networks cost money—lots of it. And whether students buy or rent their terminals, they must eventually carry a financial burden for access to the campus network. Other things being equal, the $1000 or so cost for computing represents a much smaller proportion of the overall educational charges of major private institutions than it does for the local branch of the state university. Looking at the economic and educational realities, computer companies are far more likely to link up with elite private colleges for networking experiments than with minor state universities. The educationally rich will get richer, and the poor may be left behind in the campus computer revolution. "There will be a new elite," admits Lerman. "But on the other hand, institutions like M.I.T. are superior in many ways anyway."

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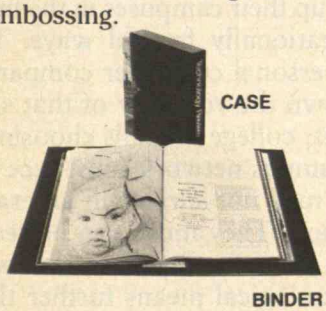

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A legitimate question arises of who, among colleges and companies, is using whom.

The Commercial Imperatives

Not surprisingly, computer companies are competing furiously to join up with the elite. Apple, Digital, and IBM, in particular, are trying to outdo each other, and smaller competitors, by offering discounts to individual students and faculty members of colleges that adopt their projects, and making outright grants for research on campus networks. Hewlett-Packard plans to give colleges $30 million worth of equipment this year. Digital announced in June that it would give $45 million worth of products over the next three years to promote the use of computers in higher education. And earlier this year IBM announced two separate grants of $10 million each in equipment and technical support—to the University of California, Berkeley, and Stanford University.

The computer-makers' motives go well beyond the hope of short-term sales. Indeed, the immediate sales potential is limited by the relatively small number of colleges at present committed to computer networks. Even the concept of brand loyalty—the idea that students who have used an Apple, say, in their college days will insist on the same hardware and software when they join the executive ranks—seems to play a relatively minor role in the computer manufacturers' corporate thinking. Far more important is the opportunity to benefit from research that uses individual companies' products. The universities in Apple's Macintosh consortium, for example, will develop courseware and software for education. While the universities will share the developments—and any marketing profits—among themselves, Apple will benefit from the availability of new software specifically targeted to its computers.

There's also the need to be part of a new development as early as possible. "We are prepared to spend money to find out if computers are really applicable to education," says Robert F. Trocchi, product group manager at Digital. "Education is a microcosm of the computer world."

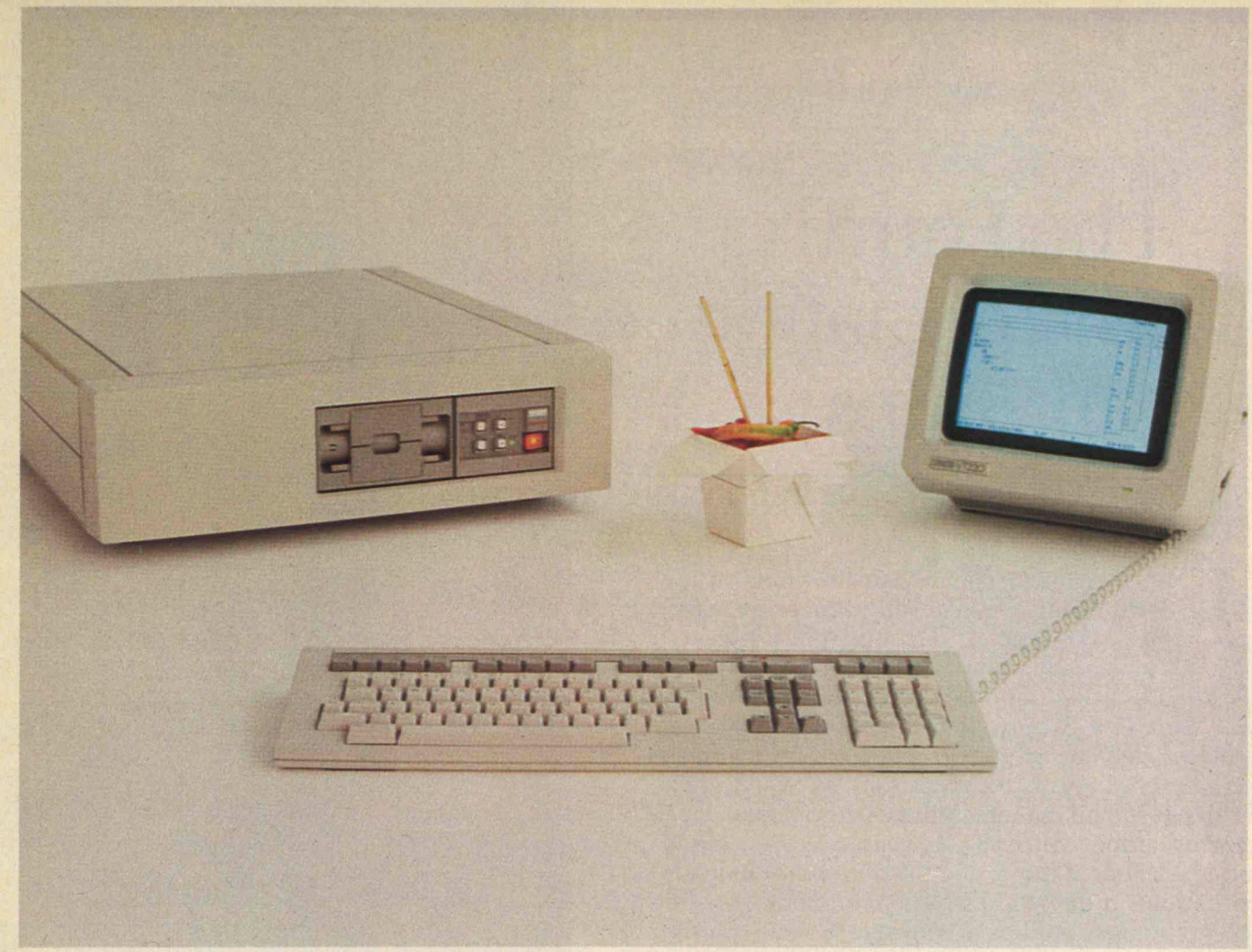
Even the computer manufacturers admit the potential for trouble if educational administrators are oversold on any particular company or type of equipment. New Hampshire Governor John Sununu recently received a barrage of criticism when he approved purchase of $3.5 million of Digital equipment for state elementary schools, despite school officials' complaints that the machines were unsuited for elementary teaching. If a college becomes too willing a captive of a specific manufacturer, it may find itself committed to the wrong computer infrastructure, warns Stanford education professor Henry Levin. And Trocchi cautions that college administrators must guard against the temptation to let the technology, rather than educational needs, dictate their choices of equipment and manufacturers. Computerized education, he says, "is more than terminals and wires. It's more than the idea of getting the curriculum done fast rather than in the spirit of learning."

The close links between colleges and computer makers pinpoint another potential problem, involving the academic freedom to publish freely any and all work that results from research projects. Several colleges that have signed up with computer manufacturers will receive hardware that the manufacturer still regards as commercially confidential. In effect, the colleges might be perceived as specialized research departments of the companies.

On the other hand, the colleges that sign agreements with computer manufacturers are hardly going in with an air of total innocence. They stand to gain enormously from the equipment, technical advice, and cash grants that the companies provide. Indeed, a legitimate question arises of who is using whom. "I don't think there are any virgins here," comments Lerman. "We're involved in a partnership in which we can each get something out of each other. Digital and IBM have long-term economic interests at heart. We have long-term M.I.T. interests at heart. If these interests don't conflict, we're fine. We're using each other to mutual advantage."

Plainly, college administrators face plenty of pitfalls as they try to wire up their campuses in the most cost-effective but educationally fruitful ways. The rise and fall of small personal computer companies in recent years has shown the volatility of that slice of the computer market; college officials choosing a company to create a campus network must face the risk that the company may not survive in an era of even tougher competition. They must also be ready to withstand pressure from faculty members who want to push the technological means further than is desirable for the college's educational ends. The real challenge is to computerize campuses as efficiently, but also as humanely, as possible.

PETER GWYNNE is managing editor of Technology Review.



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The Fourth Transformation in Autos

BY JAMES WOMACK AND DANIEL JONES

THREE significant and dramatic transformations during the first 100 years of its existence have brought the automobile industry from a small group of artisans and tinkerers concentrated in France and Germany to a vast worldwide enterprise. Now a fourth transformation, the result of high technology applied to automobiles and—especially—to the operations by which they are designed and manufactured, is in progress. This transformation will bring new pressures on labor and international trade, and the position of individual nations in the world's future auto industry will depend on their policies in response to these controversies.

The product changes of this fourth transformation will not dramatically alter the basic character of the automobile—no new types of engines will be introduced, and vehicles of the 1990s will probably look quite like today's. However, the new technologies will allow automakers to adapt their vehicles to changing safety, energy, and air-quality standards. In contrast, the changes in the design shop and on the factory floor brought by flexible automation will be highly visible, and they will fundamentally alter the nature of the industry. The need for semiskilled and unskilled labor will be greatly reduced, and smaller companies will be able to compete with industry giants in producing a large variety of vehicles.

Automobiles of the coming decade may not look very different from today's. But the industry that manufactures them will be revolutionized by flexible automation.

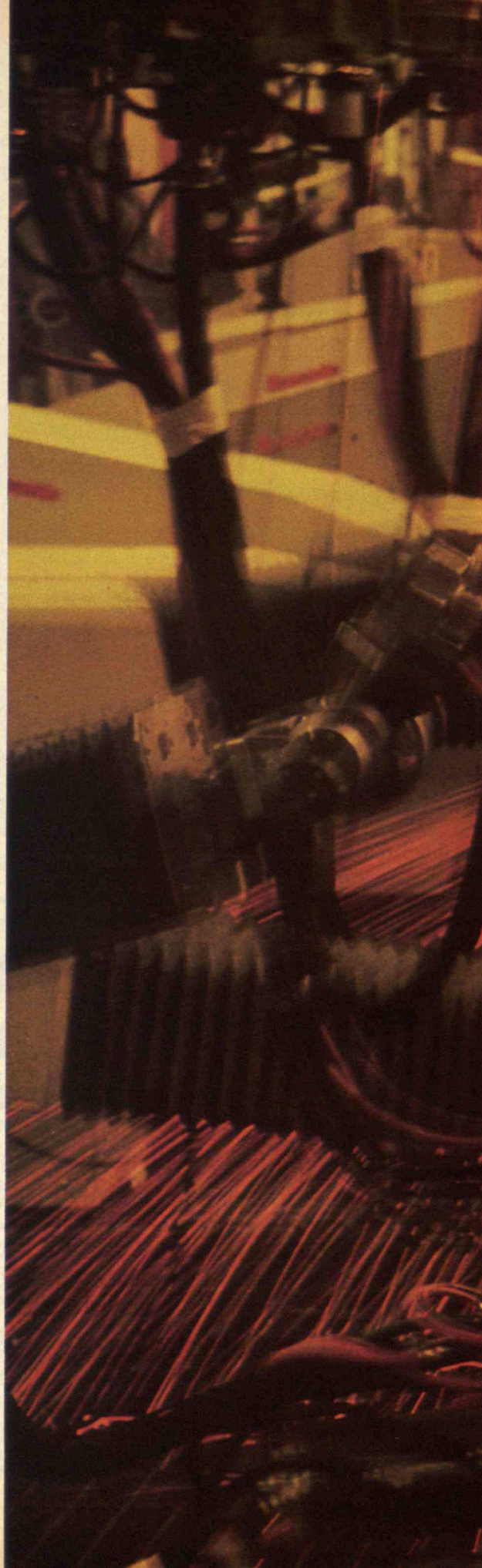
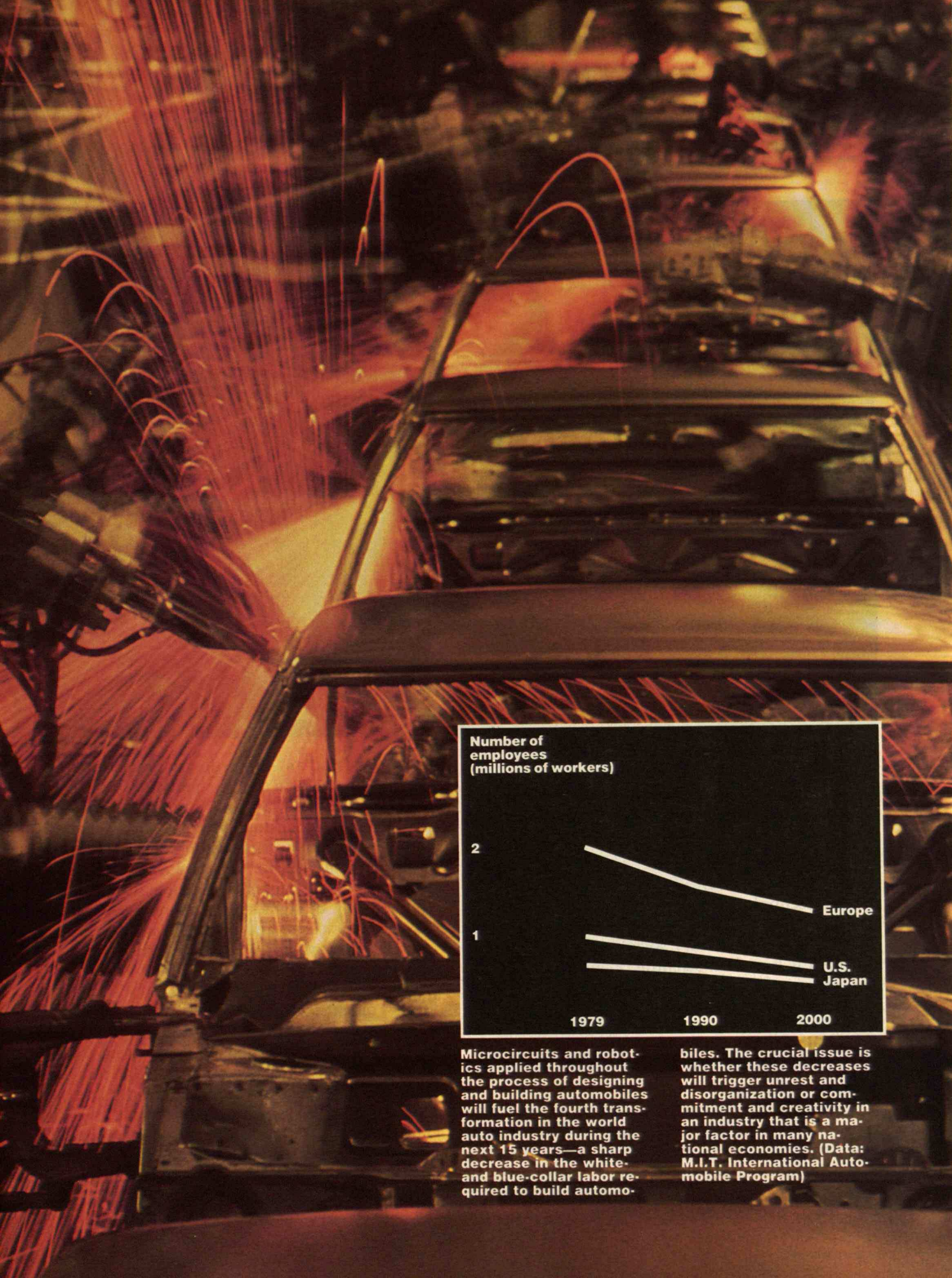
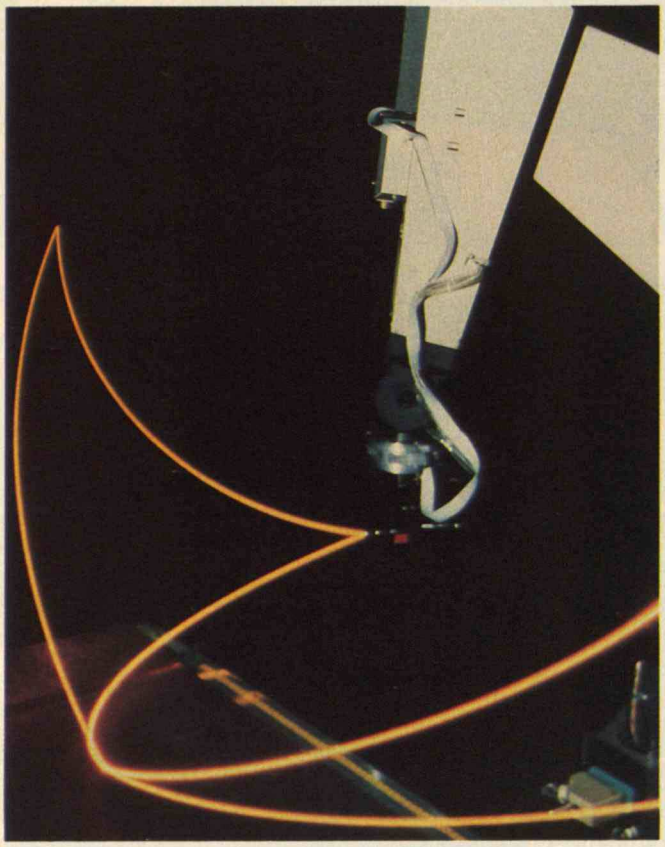


PHOTO: DICK DURRANCE, WOODFIN CAMP



Microcircuits and robotics applied throughout the process of designing and building automobiles will fuel the fourth transformation in the world auto industry during the next 15 years—a sharp decrease in the white- and blue-collar labor required to build automobiles. The crucial issue is whether these decreases will trigger unrest and disorganization or commitment and creativity in an industry that is a major factor in many national economies. (Data: M.I.T. International Automobile Program)

New developments in computer-aided design and manufacturing already mean that designers' sketches for automotive components can be automatically translated into detailed drawings (right)—and soon such sketches will be all that is required by the automatic machines that fabricate the parts. Robots will displace most assemblyline workers as engineers redesign vehicles, assembly systems, and the automatic machines themselves (left).



Autos for Everyone

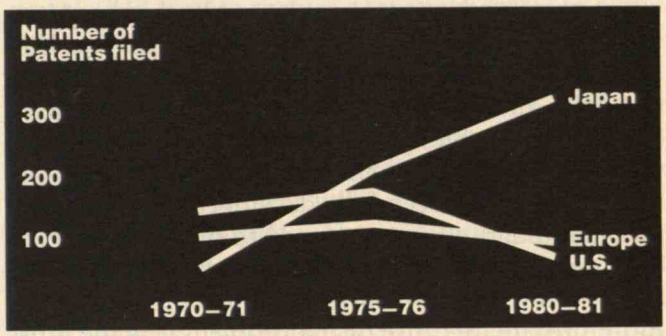
The first episode of dramatic change in automaking saw the transition from a custom-built, low-volume product for the well-to-do to a mass-produced, standardized car for everyone. This American transformation, led by Henry Ford, combined a new production technology (moving assembly) with both a new type of product (the standardized Model T) and a novel system of factory social organization. That system was based on scientific management principles commonly called "Fordism," in which each worker is assigned a routine task to perform repeatedly. The effect was to dramatically reduce costs and create a massive industry, shifting a large portion of the world's auto production to the United States from Europe.

The second transformation was led by the Europeans after World War II. Because of differences in their countries' taxes and tariffs, travel patterns, road conditions, and national tastes, each European auto industry had gone its own way. As a result, when tariff barriers began to fall in the 1950s, the Europeans had an extraordinary range of models to offer consumers in foreign markets. To American observers this was a sign of an immature industry still wedded to custom products and "craftsmanship." U.S. producers had long before settled on a single standard size for cars, and Americans assumed that this would happen in Europe also. A few producers, they thought, would increase their volume, reduce their costs, and drive the smaller producers out of what was viewed as the preeminent scale-economy industry.

In practice, the opposite happened. European producers quickly capitalized on their diversity by filling a multitude of market niches to make major inroads in the U.S. market—first at the bottom with cars such as the Volkswagon Beetle and later at the top with touring cars such as the Mercedes and Jaguar that today claim much of the U.S. luxury market. The American standard-size car was too large and guzzled too much energy to find markets overseas, and so began the loss of market share that was turned into a rout for U.S. automakers by the oil crunch of 1973.

PHOTOS: GM RESEARCH LABORATORIES; FORD MOTOR CO.

Patents do not translate directly into innovations reaching the marketplace. But these data on the number of ideas being placed under proprietary control in the U.S. by various nations' automakers suggest the strength of Japan's effort to build a base of automotive technology. (Data: Office of Technology Assessment)



The third transformation, starting in the mid-1960s, was the work of the Japanese producers. These automakers perfected Henry Ford's system of mass production by introducing two new concepts, by now well known. The first, called "total quality," gave workers within the plant more responsibility for the organization and performance of their work. The second, known as "just in time," streamlined the delivery of goods from the multitude of firms needed to produce the many parts, designs, and production tools for making automobiles. These breakthroughs at first gave Japanese producers a tremendous advantage in world competition. However, today producers in the United States and Europe, many of them Japanese subsidiaries, are rapidly copying this philosophy, greatly intensifying world competition.

The flexible manufacturing system of the fourth transformation will have even greater consequences for the industry. These changes will occur in addition to the more subtle technological advances introduced inside the auto itself. The latter will be evolutionary because automakers know today's vehicles satisfy most consumers, and because the process of adding new systems to automobiles is neither as simple nor as quick as many people assume.

Putting New Technology in Automobiles

The first task of those who would introduce new technology into an automobile is to master the complex and modular nature of the modern vehicle. The basic structure (the body, in everyday language) serves as an armature for a growing number of essential systems. These include the power train to get the car going, brakes to stop it, suspensions to mediate between passengers and the road, and lighting and windshield wiping to make the auto usable around the clock. Other vital systems permit the driver to manage the vehicle (the steering, accelerator, and brakes), the vehicle to communicate with the driver (the instruments), and the systems within the vehicle to communicate with each other (for example, transmissions that adjust gear ratios to engines' operating modes). Modern vehicles also contain a host of comfort and convenience features as well as emission controls and crash protection for riders.

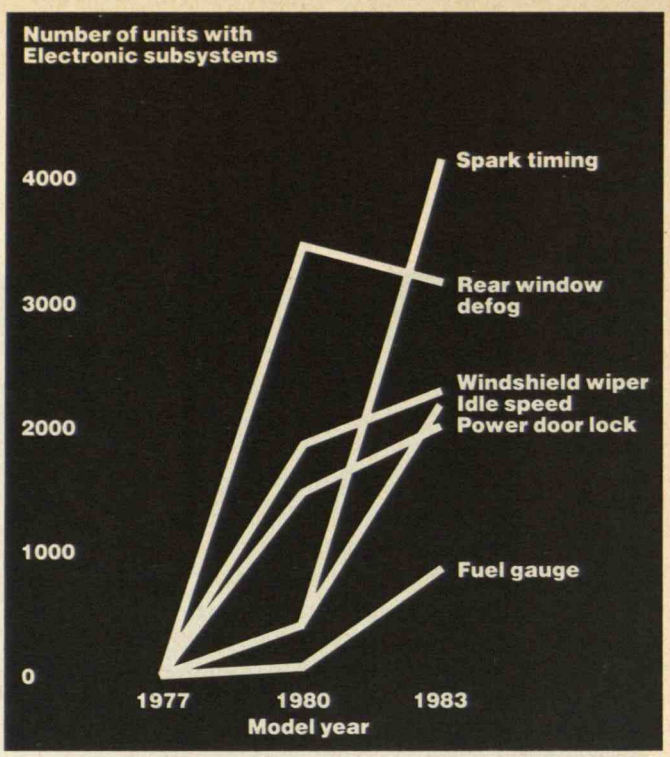
The vehicle designer's challenge is to tune these systems to work together harmoniously. Because interactions among the many systems are complex, harmony would be difficult to achieve even if the technology of the system were constant. But the only constant of technology is change, and a key objective for the designer is to incorporate new technology that will improve the vehicle. Developments for various systems proceed at different speeds and in different directions, and maintaining harmony is a true art.

It is chiefly for this reason that incorporating a new system into a car model takes so long. Bringing the system from a concept on paper to a prototype that really works can often take a decade or more. Moving from prototype to marketplace takes about four more years. Half or more of this time is typically devoted to trying the new system out on test beds, and then in prototype and preproduction vehicles, to see what happens to performance when something new is added. Since the results are likely to be a mixture of bad and good, several time-consuming repetitions are usually needed. Even after a new technology enters production, feedback from users often leads to additional tuning of the system. Expensive and embarassing recalls may be required if performance is grossly deficient. Because the cost of developing a new system and incorporating it in a vehicle is high, the innovation must sustain its market appeal for a long time.

These constraints explain why vehicle designers tend to apply new technologies to one area at a time—a so-called incremental design procedure. For example, microprocessor controls were added to engines beginning in the mid-1970s, to transmissions in the early 1980s, and to suspensions in the mid-1980s. This step-by-step process minimizes the chance of a disastrous error. Auto designers must be visionary but they must also be cautious.

Not surprisingly, the designer's nightmare is the

DIAGRAMS: OMNIGRAPHICS



The use of electronic subsystems in U.S. automobiles has increased dramatically in the past five years, but the most important and comprehensive applications—in skid control, steering, and suspension, for example—are still to come. Even these changes, however, will be dwarfed by the revolution that microcircuits and robotics will bring automotive design and manufacture. (Data: Arthur D. Little, Inc.)

prospect of putting an entirely new technology into the whole product line on short notice. For U.S. automakers, that nightmare became reality during the 1974 and 1975 model years, when government-imposed timetables gave them only one or two years to develop and install emission-control systems. No technologies had been fully developed as prototypes, and manufacturers were forced to prove their products on the road. Although the public widely condemned the industry for its technical ineptitude, the more proximate cause of the problem was the gross violation of the automakers' tried-and-true approach to introducing innovations.

A final problem faced by the vehicle designer in the conventional innovation process is the conservative mindset of most consumers, who are devoted to a familiar product that is already satisfactory in most respects. A recent example is the concern with aerodynamics. A truly aerodynamic auto body looks different—indeed, decidedly strange—to many consumers. The designer's challenge is to bring along traditional as well as less conservative purchasers by introducing aerodynamic features gradually.

Alternatives to incremental innovation offer producers the prospect of greater rewards but hold substantially greater risks. One alternative is to start from scratch, choosing from available technologies to put together a dramatically new vehicle. Though each system in such an automobile may be familiar, the overall effect, when the systems are recombined, may be something quite unusual with an enormous competitive advantage. Henry Ford's Model T is the archetypal example of what can happen when this strategy works.

Another alternative to incremental change, with even higher risk but higher potential payoff, is to build a wholly new vehicle around a single truly radical technology. This tantalizing avenue is littered with noble failures. An example is the heavy commitment of Toyo Kogyo to the Wankel rotary engine. That engine made the company's Mazda cars world-famous and continues to set the RX-7 sports car apart from all its competitors. But the Wankel rotary, and with it Toyo Kogyo, only narrowly escaped extinction in the mid-1970s when high fuel consumption made Mazda's models uncompetitive.

These constraints on innovation contrast with the potential for sudden change in the auto's "operating environment" (such as a renewed fuel shortage) and for the appearance of dramatic new technologies (such as the microprocessor in the 1970s). The alternatives to incrementalism suggest that radical innovation may be possible, but the problems facing the innovator loom large. However, over time, as in the case of a growing child, the incremental approach can produce something dramatically different. This will be the case over the next two decades, as automakers incorporate new microprocessor-based technologies and lighter and stronger materials into their products.

Technology for the Fourth Transformation

The auto industry is predominantly a borrower of new technologies developed elsewhere, and this was certainly the case with the microprocessor, which was first created for specialized military applications. However, this technology raised such attractive possibilities for new automotive functions, and for easier ways to perform old ones, that auto designers were certain to experiment with it. Adapting the microprocessor to real-world autos has not been easy, though. A technology originally designed to work in a vibration-free, air-conditioned environment must operate under the hood of a car in conditions of thermal shock, extreme vibration, relentless grime, and electromagnetic interference as intense as enemy jamming in military use. And because most microprocessor systems function by instantly assessing situations, they must be "fail-passive" so that the auto continues to operate, though at a reduced level, if they fail. Although the industry has made great strides in dealing with these problems, it hasn't solved them entirely.

PHOTOGRAPHIC RESEARCH: SUSAN ELSNER

The designer's nightmare is the prospect of putting an entirely new technology into the whole product line on short notice.

The full introduction of microelectronics to come during the next 20 years will largely eliminate skidding during braking, acceleration, and turning. Microprocessor-controlled antiskid braking systems, originally developed for aircraft, are now in their second generation of automotive use. Antislip acceleration systems are entering the testing phase and will be available in a few years in top-of-the-line, performance-oriented models, particularly those with rear-wheel drive. This process of applying microsystems to enhance safety will be complete with antiskid steering systems that sense and react to sideslip to increase the driver's control in emergency maneuvers; these are probably 15 or more years away.

The turbocharger is a second example of a technology adapted for automobiles from another industry. This device, developed mainly for use in aircraft, uses the energy in an engine's exhaust stream to turn a turbine that pumps air into the cylinders at high pressure, increasing the power available. The technology has been under development for some 60 years—almost as long as there have been internal-combustion engines.

In aircraft use the turbocharger operates at nearly constant output throughout a flight, can be easily cooled by airflow during flight, is carefully run up to operating temperature before takeoff, and can be shut down to cool after landing when its contribution to power is no longer needed. However, in automotive use none of these advantages applies. The output of the turbocharger is needed instantly, at irregular intervals, for acceleration. The unit is often run hard while cold and shut down while hot. In some early uses in cars the result was severe bearing wear. Auto technologists are nearly a decade into second-generation uses of the turbocharger, yet they have still not mastered all the problems of incorporating it into a wide range of vehicles with smaller engines.

Once its performance has been perfected, such a new system must be produced at a competitive cost with very high quality if it is to move from the specialty market into mass production. Turbochargers now use rotary parts made of steel alloys, which are difficult and expensive to cast and machine. However, some firms are seeking ways to substitute ceramics because the raw materials are cheap and light and the manufacturing process may prove to be simpler. A breakthrough in production costs of ceramic parts could lead to the use of turbochargers in many vehicles.

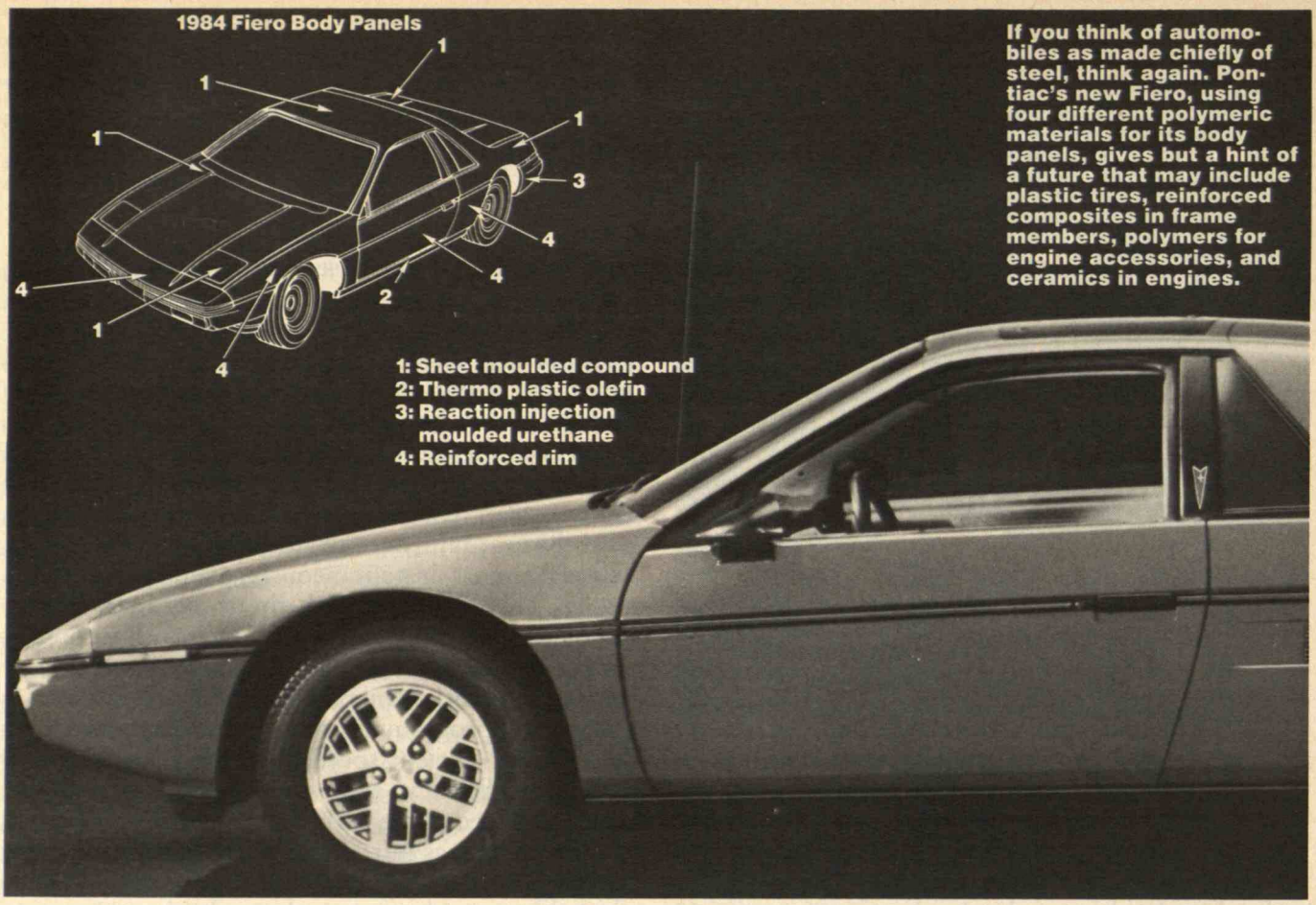
Clearly, restocking the "shelf" of prototype components and technologies involves much trial and error and many dead ends. The process also tends to leave many bits and pieces and half-finished designs awaiting breakthroughs in other areas or shifts in market conditions. The continuously variable transmission (CVT) is a good example. Such devices vary the gear ratio between the motor and the driving wheels almost instantaneously over a continuous range. This contrasts with the three, four, or five ratios available in current manual and automatic transmissions, with the need to uncouple the motor and drive wheels while shifting between ratios.

Properly programmed to keep the engine working at its most efficient speed, a CVT yields substantial gains in efficiency. CVTs were first developed and even produced in the early years of the industry, and a simple CVT was introduced in the late 1950s in the Dutch Daf, a small car designed to appeal to first-time drivers with qualms about shifting. However, to achieve the CVT's potential for higher efficiency, a more sophisticated system was needed to coordinate the engine, the fuel supply, and the friction surface of the transmission. Also required was a jump in energy prices so that the CVT's fuel economy would offset its higher manufacturing cost. The perfection of the microprocessor and more durable surface materials have now combined with higher energy prices to move CVT development rapidly ahead, and the system will soon be mass-produced.

Saving Energy

Fuel economy will continue to be an impetus for technical innovations. Unlike air quality, noise, and even safety, fuel efficiency is a high-visibility issue for consumers as well as governments. There are three promising paths for markedly reducing vehicle energy use.

The first involves improving the aerodynamics of auto bodies. This process can be as simple as reshaping a fender or smoothing a contour of the rear-view mirror. However, aerodynamics is currently as much an art as a science, often requiring lengthy experimentation with mockup vehicles in wind tunnels. Thus, the technologist's short-run task is to perfect specialized automotive wind tunnels that are able to model subtle aerodynamic effects. The



longer-run challenge is to develop computer-aided design packages to calculate drag accurately from drawings or models.

A second way to improve fuel economy in a vehicle of given carrying capacity is to reduce weight. Auto designers have already incorporated high-strength steels in key body stampings, substituted aluminum and plastic for steel in exterior body panels and bumpers, reduced the thickness of glass, and reduced rolling resistance by switching to radial tires. However, the potential is much greater, and it will surely be realized during the next 15 years as knowledge of nonferrous metals, polymers, and fiber composites increases.

The third way to improve fuel economy is to refine electronic engine controls. For instance, continuously-operating devices such as water and oil pumps, air-conditioning compressors, cooling fans, and power steering and braking systems will be replaced by microprocessor-controlled motors that consume only as much energy as needed.

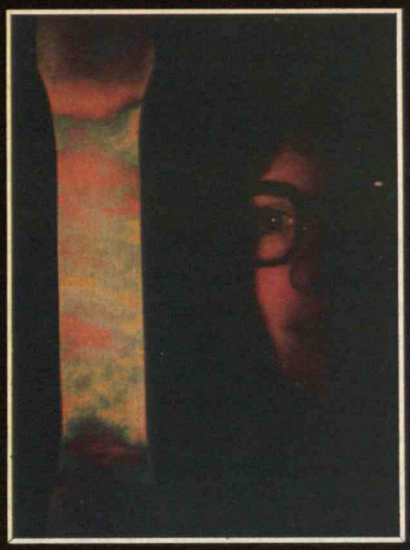
New Ways of Making Automobiles

Changes in the process of making autos are the core of the fourth transformation. Computer-aided design (CAD), using minicomputers and sophisticated software packages, will allow the designer to accomplish quickly with a television screen and light pencil the once-tedious task of making detailed drawings with paper and lead pencil. Designers are tying these systems to computer-aided engineering packages that ease the task of calculating shapes and choosing the best materials for specific assignments. The third step in this electronic network is computer-aided manufacturing (CAM), which transfers the coded instructions from the CAD screen to the robots and other flexible equipment needed to fabricate the parts. Eventually, an electronic path between designer and production machinery will reduce design time and labor while improving product quality and reliability.

On the shop floor, the basic tasks of building a car—fabricating thousands of parts such as gears and housings, assembling them into components such as pumps and transmissions, making the body, and installing the components within the body—will all be transformed.

In the body plant, the stamping of the roughly 300 needed parts from sheet steel will be more highly automated. If plastic body parts are used, they will be molded by automated equipment. These parts will then be welded or glued together by robots, which will be programmed to handle a wide variety of body styles and options on the same assembly line. Paint will be applied by a new generation of the painting

PHOTO: PONTIAC DIVISION, GM CORP.



The world automobile industry is turning increasingly to high-strength steel and new polymer structures in its quest for lighter, stronger, and more durable materials. Left, a Nissan technician tests a steel sample for response to stress. Right, a polymer sample is tested for strength under polarized light at GM's Research Laboratories.

robots already at work in most of the world's car plants. And final assembly will also be automated. Cars will be redesigned to require less assembly, particularly in their cramped interiors, with the result that robots will be able to perform almost all functions now assigned to assembly workers.

Quality inspection will also change. Flexible machinery will increasingly be able to check its own mistakes, and cars assembled of perfect parts will probably need little inspection at the end of the line.

A final step in this process will be to link the technologies of design and manufacture with new approaches to organizing the remaining work; that is to say, to combine the lessons of the third and fourth transformations. This is the task General Motors says it is undertaking in its Saturn exercise, an effort to develop a new small car for North American production toward the end of this decade. The company plans to rethink the design of the product, the technology of the production process, and its traditional management practices in hopes of finding a dynamic new combination.

Toward Flexibility and Variety

These manufacturing innovations will be cumulative and will fundamentally alter the structure of the industry. Until recently, most observers thought the trend in the world auto market was toward a small, standardized product. This trend was expected to match nicely the automakers' need for massive scale economies that would allow a few big companies to dominate the scene as they did in America by the 1970s. Many people predicted that as the product became more standardized and price became the key influence on consumer choices, more and more auto production would move to low-wage countries such as Korea and Mexico.

However, the technological advances of the fourth transformation will reverse the predictions in each of these areas. First, the growing flexibility of automated production is combining with a clear consumer preference for variety and advances in product technology to make a wide range of automobiles practical. This will enable producers to develop cars for specific markets without paying the traditional cost penalty for smaller-scale production.

Auto producers have traditionally had to run off about 250,000 copies of each body style per year and about 500,000 copies of each engine and transmission—the capacities of conventional plants—to achieve full economies of scale. With flexible automation, a producer may still have to sell at least 250,000 cars, but one plant will be able to make different models without changing tools or halting the production line. Similarly, one plant will be able

PHOTOS: NISSAN; GM RESEARCH LABS

Manufacturing innovations based on microelectronics will fundamentally alter the structure of the world automobile industry.

to produce many variations of a basic engine or transmission design, and these could be sold to other manufacturers for low-volume product lines. Indeed, smaller producers such as Honda, Mazda, and Volvo have already combined finesse in targeting products to certain market niches with flexible production to become the most dynamic members of the industry. Traditional giants such as General Motors, Renault, and Toyota may have to work hard to adapt to the marketplace of the future that demands diverse and distinctive products.

Finally, because highly automated factories will drastically reduce automakers' need for labor, the widely anticipated shift to low-wage sites will not occur on a large scale. Instead, individual product lines will be produced mostly in the locales where they are sold. This trend will be consistent with the Japanese discovery that manufacturing as much of the vehicle as possible at the point of final assembly provides large savings in inventory costs and higher product quality. At the same time, exports of small volumes of many different models, designed to satisfy consumer demands for diversity, will also increase. In combination, these international flows of trade will be quite large.

The New Productivity Dilemma

Thus, the technological advances of the fourth transformation, more than the number of vehicles imported from other countries, will determine long-term employment levels in the auto industries of developed nations. Total employment in auto manufacturing in the United States, Japan, Germany, France, Italy, Sweden, and Britain reached a historic high of about 3.6 million in 1979. Employment will probably decline steadily to about 2.3 million by the year 2000—a 36 percent reduction. This change will occur even though demand for cars in these countries will increase by about 30 percent during this period.

Employment in the U.S. auto industry will decline by about 39 percent from the peak of 982,000 in 1979 to 596,000 in 2000. Clearly, this dramatic drop cannot be avoided by restricting imports. In-

TWA. OUR 3 PAIR BEATS THEIR

Automation means that auto production need not move to low-wage sites. Future cars will be made chiefly in the locales where they will be used.

deed, this estimate assumes that Japanese and European automakers will increase their share of the U.S. market by less than 2 percent.

More dramatic still will be the change in the types of jobs in the auto industry. In particular, assemblers and semiskilled machine operators, who have traditionally constituted the bulk of the workforce, will become endangered species. A smaller number of workers with specific skills, such as programming computers and keeping a complex automated assembly system on track, will take their place. These declines in labor needs will be exacerbated by the changes of the third transformation, which make the production process more efficient.

This trend of exploding productivity presents a dilemma for policymakers in the United States, Europe, and Japan. Nations who wish to revitalize their auto industries—or retain their vitality—to fend off import threats, preserve exports, and boost overall productivity face dramatic reductions in the workforce in what has been the "industry of industries." Policymakers will undoubtedly be tempted to slow down the transformation, particularly during declines in the auto market, by restricting imports. However, these efforts will likely affect only the pace and not the ultimate outcome of change. We believe that decisionmakers will adjust their strategies as they realize that long-term protection will only retard the technological changes each producer must make to insure future competitiveness. The question decisionmakers must confront is whether workers, many of whom will suffer permanent dislocation, must bear the full burden of these changes. And because the auto industry has such a powerful effect on our whole consumer society, these issues of adaptation will eventually involve us all.

JAMES WOMACK is a research associate in the Center for Transportation Studies at M.I.T. DANIEL JONES is a senior research fellow at the Science Policy Research Unit at the University of Sussex in England. This article is adapted from The Future of the Automobile, *published in September by the M.I.T. Press. The book, written by Alan Altshuler, Martin Anderson, Daniel Jones, Daniel Roos, and James Womack, is the final report of the International Automobile Program, a four-year, seven-nation study conducted at M.I.T. under the joint direction of Professors Altshuler and Roos.*

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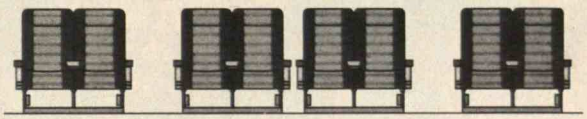

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Technology is the cornerstone of Sino-American relations. China is receiving it, and the United States is getting too little in return for it.

Technology for China: Too Much Too Fast?

In the Great Hall of the People in Beijing last April, Arthur W. Hummel, Jr., the U.S. ambassador to China, initialed a working agreement allowing American firms to sell nuclear technology to the Chinese. Looking on, President Reagan hailed the accord as "a new dimension of peaceful cooperation" between the two nations.

The United States had encountered one significant hitch in negotiating the treaty: the question of whether the Chinese might use spent fuel from U.S.-supplied reactors to make nuclear weapons for themselves or for other countries such as Pakistan. When Chinese Prime Minister Zhao Ziyang was in Washington in January, he discussed this issue with U.S. officials. In a dinner toast at the White House, he pledged, "We do not engage in nuclear proliferation ourselves, nor do we help other nations to develop nuclear weapons."

However, acccording to press reports in late June, there was evidence that the Chinese might be supplying nuclear-weapons technology to Pakistan. The press also quoted State Department officials as saying that Zhao's toast, repeated in a subsequent speech, was the primary guarantee the United States had from China against nuclear proliferation. When Secretary of State George Schultz questioned Chinese Defense Minister Zhang Aiping about this guarantee, according to the *New York Times*, Zhang was outraged and would not discuss a pledge already made by Zhao.

The process leading to this latest agreement was in many ways typical of Sino-U.S. relations. The Chinese pushed to acquire an advanced "civilian" technology (one of their chief obstacles in industrial development is a chronic shortage of energy) that also had potential military applications. Despite concern that the United States would receive little in return, State Department officials warned that blocking the agreement would damage the fragile friendship with China. Too often this country is so nervous about its relationship with China that it fails to secure adequate political concessions for what the Chinese want most—technology.

Instead, the United States has steadily relaxed con-

BY DENIS FRED SIMON

ILLUSTRATION: PAUL TURNBAUGH

trols on the export of technology to China, putting the Chinese in the same general trading category as most U.S. allies, and U.S. investment in China has been growing steadily. The two countries have also signed many agreements for cooperating in scientific and technological in fields ranging from high-energy physics to industrial management. For example, the Chinese Academy of Sciences, the most prestigious research organization in China, has agreed with the National Science Foundation in this country to promote the exchange of researchers and cooperate in scientific fields of mutual interest. At the Dalian Industrial Science and Technology Institute in China, U.S. business experts sponsored by the Department of Commerce are working with the Chinese to improve their industrial management. And some 11,000 Chinese students and scholars, almost all in science or engineering, are at U.S. universities.

I do not wish to suggest that I think this country should stop this flow of technology to China. That would be a grave error with negative long-term implications for the United States. According to its own official statements, the U.S. government is committed to supporting a stable China with an improving economy, and I believe that such a China would be more responsible internationally than one beset by serious development problems. What I object to is that U.S. officials fail to appreciate the role of technology in foreign policy. They tend to see technology transfer as a mere frill, focusing instead on the balance of power among the Soviet Union, China, and the United States, or on the unfulfilled potential of the China market.

The Chinese are under no such illusions. They see U.S. willingness to transfer technology to China and to exchange scientific work as indicative of America's commitment to bettering relations. When Deng Xiaoping, China's leader, wanted to promote improved U.S. relations within the Chinese government, one of his main selling points appears to have been the promise of technological benefits.

But even when the Chinese receive these benefits, they do not tone down their anti-U.S. rhetoric. They continue to criticize U.S. policy in Central America, the Middle East, and the Third World in general. They still tend to label the United States and the Soviet Union equally hegemonist. China manufactures reasons why it cannot accompany North Korea to discussions with both the United States and South Korea about easing relations in that divided country.

Other exchanges, too, tend to be one-sided. Chinese scholars in the United States have free access to a wealth of resources in libraries and government agencies such as the National Technical Information Service. However, U.S. scholars in China—primarily social scientists studying the country—continue to encounter substantial obstacles in everything from selecting research projects to gaining access to publications, statistics, and other materials. Given the nature of Chinese society and the confusions within different levels of government, it would be unreasonable at this time for U.S. scholars to demand completely free access in China. However, the Chinese government could help by articulating its general acceptance of U.S. scholars' objectives.

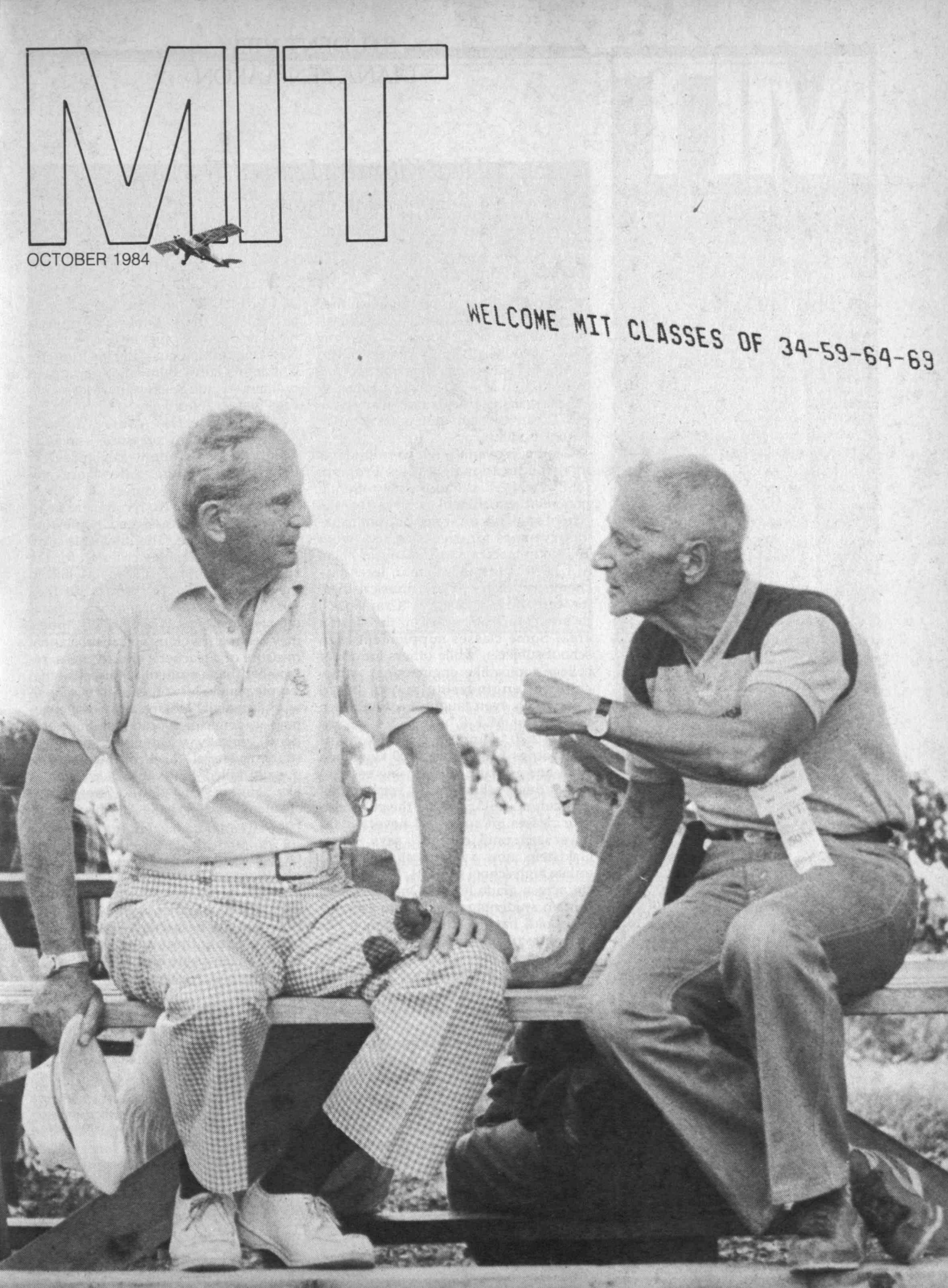
At the insistence of Western business leaders, the Chinese have finally enacted a law to protect foreign patents. However, they have done this only reluctantly, since "reverse-engineering," or the process of copying imported technology, is common there, as it is in other developing countries. There is also some question as to how effective the patent law will be.

In short, the technological relationship between the United States and China has far outpaced the level of mutual political understanding. As long as China remains reluctant to work more fully with the United States on international issues—or at least to agree not to work against U.S. interests—I believe we may be allowing our technology transfer to China to go too far too fast.

PHOTOGRAPHIC RESEARCH: SUSAN ELSNER

MIT

OCTOBER 1984



MIT
OCTOBER 1984

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ABOUT THE COVER

The essence of Reunion '84, moments of festivity and of quiet conversation like that shared by members of the Class of '34 (cover), was captured with impressive sensitivity by Frank Revi, '86. Since finding his first camera at age six, Revi has spent a lot of time behind the viewfinder, but he reverses the roles when indulging his passion for Ultimate Frisbee (above). Photo by Leif LaWhite from Technique.

DIANA BEN-AARON

How Kittredge Learned Teaching by Trying It

Every Saturday morning when they were in high school, George Maalouf, '87, and his friends Joe Gray and Wing Chang Chow went to classes at M.I.T. That statement is quite correct even though M.I.T. abolished Saturday classes many years ago and, in any case, M.I.T. subjects are not open to high school students.

George, Joe, and Wing were students in the Educational Studies Program (ESP), an M.I.T. student activity offering noncredit enrichment courses to high school students on weekends and summer evenings for over 25 years. About 100 volunteers a year, many of them M.I.T. students and alumni, teach biochemistry, game theory, musical theater, early Russian history ("Czar Wars") to students from all over the Boston area. Some classes supplement high school subjects, while others introduce college topics like engineering. A mechanical engineering major, Floyd Kosch, '82, even taught a scaled-down version of M.I.T.'s famous design course 2.70, complete with a contest. (The kit, as I recall, was 100 keypunch cards and as many staples as necessary.)

"My high school had a very limited curriculum. ESP gave me the chance to take classes on subjects I never would have seen until college," says Stacey Goldstein, now a UMass student. And unlike high school subjects, ESP courses cut across grade levels. One class may contain students ranging from 11 to 19 years old, having little in common but an interest in the subject.

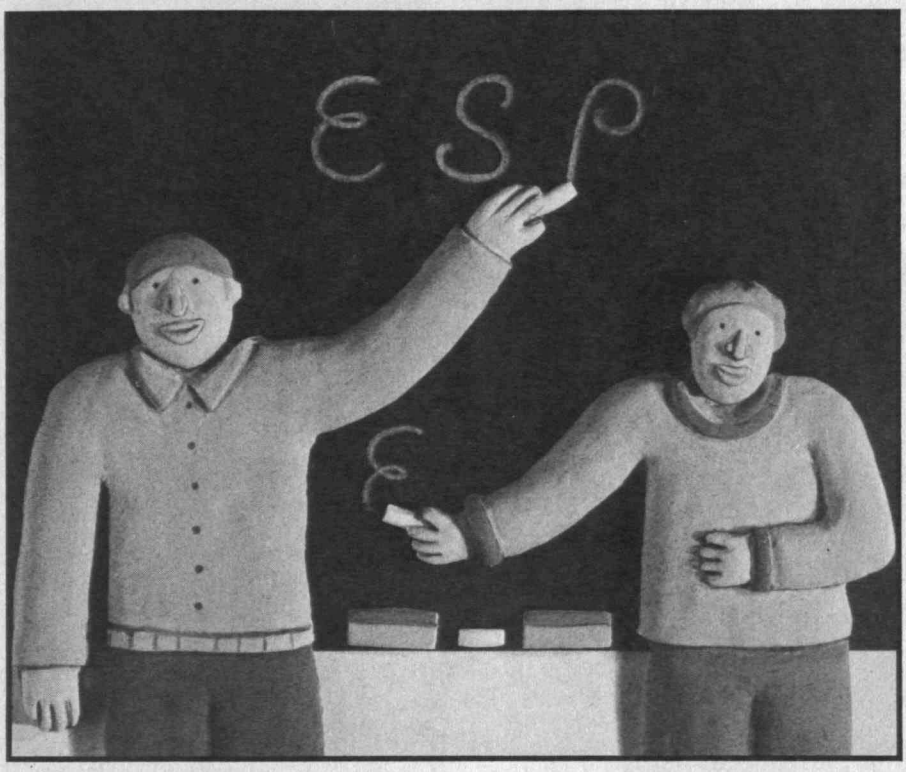
I am one of over 20,000 students from more than 150 public and private schools who have enrolled in ESP projects. In fact, I would never have considered applying to M.I.T. if I had not already become familiar with the campus through ESP. About 30 ESP alumni enter M.I.T. as freshmen annually, and many return to the program to teach or administrate. One of these, Miguel Mitchell, '81, alarmed by cutbacks in local schools (Mitchell is an alumnus of Boston Latin School), established the Massachusetts Science Institute (MSI) within ESP to offer college-level math and science courses to selected applicants whose high schools do not have the resources to challenge them. Other ESP projects have included helping the nearby city of Newton develop an "Engineering for Children" curriculum and serving as preliminary judges for the Massachusetts State Science Fair.

"ESP let me take courses in neat things without any pressure," says Regis Donovan, student at Rensselaer Polytechnic Institute. Attendance and performance in ESP courses are entirely up to the student. No records are kept, no credit or grades assigned; homework and tests are rare. The inevitable attrition provides a simple criterion for the success of a course: if students like it, they will continue to show up; if they don't, they will opt for pinball or roaming the Institute. While crowd appeal may seem a frivolous and insubstantial measure of a teacher's effectiveness, remember that a student who seeks out a supplement to his contemporary schoolwork is usually looking for a challenge, be it academic or avocational. Such students typically reject fluffy, nebulous course material. Lack of interest frequently killed ESP subjects with titles like "Humor: One Key to Stress Management" and "What's All This Science For, Anyway?".

Origami and the Bard

ESP performs a real service in introducing students to other ways of learning. In one of the best courses I took as an ESP student, three members of the M.I.T. Shakespeare Ensemble (Z Smith, '81, Jonathan Ivester, '78, and Ignazio Bellafiore, '82) introduced us to their technique of breathing life into the Bard. We spent most of our time closely study-

DIANA BEN-AARON, '85, who contributes regularly in this space, is editor-in-chief of *The Tech*. She is majoring in humanities and materials science.



ing extracts from the plays, dissecting the passages word by word. The chief strength of the class was the feeling of activity and cooperation we generated by working together. We performed for one another to prove we understood what we were saying and to practice stage technique. The class was not geared to performance, but it was a great success as an unusual literature course.

ESP provides an ideal laboratory for exploring such alternative classroom situations. ESP instructors have taught geometry with origami and physics through musical instruments. Teachers rapidly become skilled at producing different analogies on the spur of the moment, searching until they find a way to present concepts in langugage each student can understand.

And they are quick to admit mistakes. "If you asked questions they couldn't answer, they admitted it and sought the answer, for us and for them. In high school if teachers didn't know the answer they would often bullshit or ignore you for asking it," says Elizabeth Glaser, now at Wellesley College. "Having teachers not much older than oneself who were still in some stage of formal education made the educational process more alive to me," she observes.

Math teacher Joseph Shipman, '82, used a Rubik's Cube to illustrate group theory. His students were more familiar with Rubik's Cube as a puzzle than Shipman was, but were almost totally ignorant of group theory. By finding common ground, he was able to get them to stop thoughtlessly solving the cube by sheer spatial and logical ability and see it as an example of far more meaningful constructs. One of the students in Shipman's class, George Maalouf, developed an interest in the applications of group theory to chemisty and became an authority—even a bore—on the subject. (No offense, George).

How It Looks from the Blackboard

Another of ESP's valuable side effects is the chance it gives college students to view the classroom from the other side. "Teaching for ESP showed me what my high school teachers had to go through and gave me a better appreciation for them," explains Ronald Becker, '87, who teaches pre-calculus in MSI.

Kathy Kittredge (Wellesley, '83), an ESP physics teacher, once taught a section of academically talented students and a section of students with varying abilities in the same term and from the same syllabus. She reported a difference between the two groups: "The academically talented ones want to do it themselves. The mixed group, although some of them are very bright and should really be in the other class, are content with watching me work the problems."

ESP teachers learned that there are ways to make every classroom a more human place. For instance:

☐ Ask for student input, as the Shakespeare teachers did. It was to their credit that they were willing to lay their prosposed curriculum plans on the line and ask our advice. Our decision to learn a few scenes well, rather than skimming many, was to everyone's benefit.

☐ Teachers can also seek critcism on a more personal level. When I taught calligraphy, I asked my students to tell me whether they were bored or falling behind, whether I was picking on them or neglecting them, whether or not the course suited their purposes. And, perhaps because I was almost their peer, they were blunt. One told me he couldn't work well with me looking over his shoulder as I walked by him. Thereafter I relied less on surveillance and more on students, asking for help. Fortunately, they were responsible enough to request it often.

☐ Students sometimes don't voice objections because they don't know they have them. The teacher has to figure it out. When I found no one was using my worksheets the way I had intended (as practice sheets for tracing letters on), I changed them to reference guides with detailed instructions for forming the letters. This had the additional benefit of making the students less dependent on my blackboard technique.

Best of all, no-risk ESP courses encourage experiment. Kathryn Chamberlain, '85, went to ESP for computer courses. "I wanted to take BASIC and FORTRAN. When I got there, I found they weren't offering BASIC that term, so I looked around for something else to take," she said, "and ended up taking the theater course. I took every computer course and every theater course I could after that," she continued. She has since acted in, directed in, and produced many shows for ESP and M.I.T. No-Frills Theater. ☐

ILLUSTRATION: KEN GOLDSTROM

Of Course You Need Money But What You Really Need Is Talent, They Said

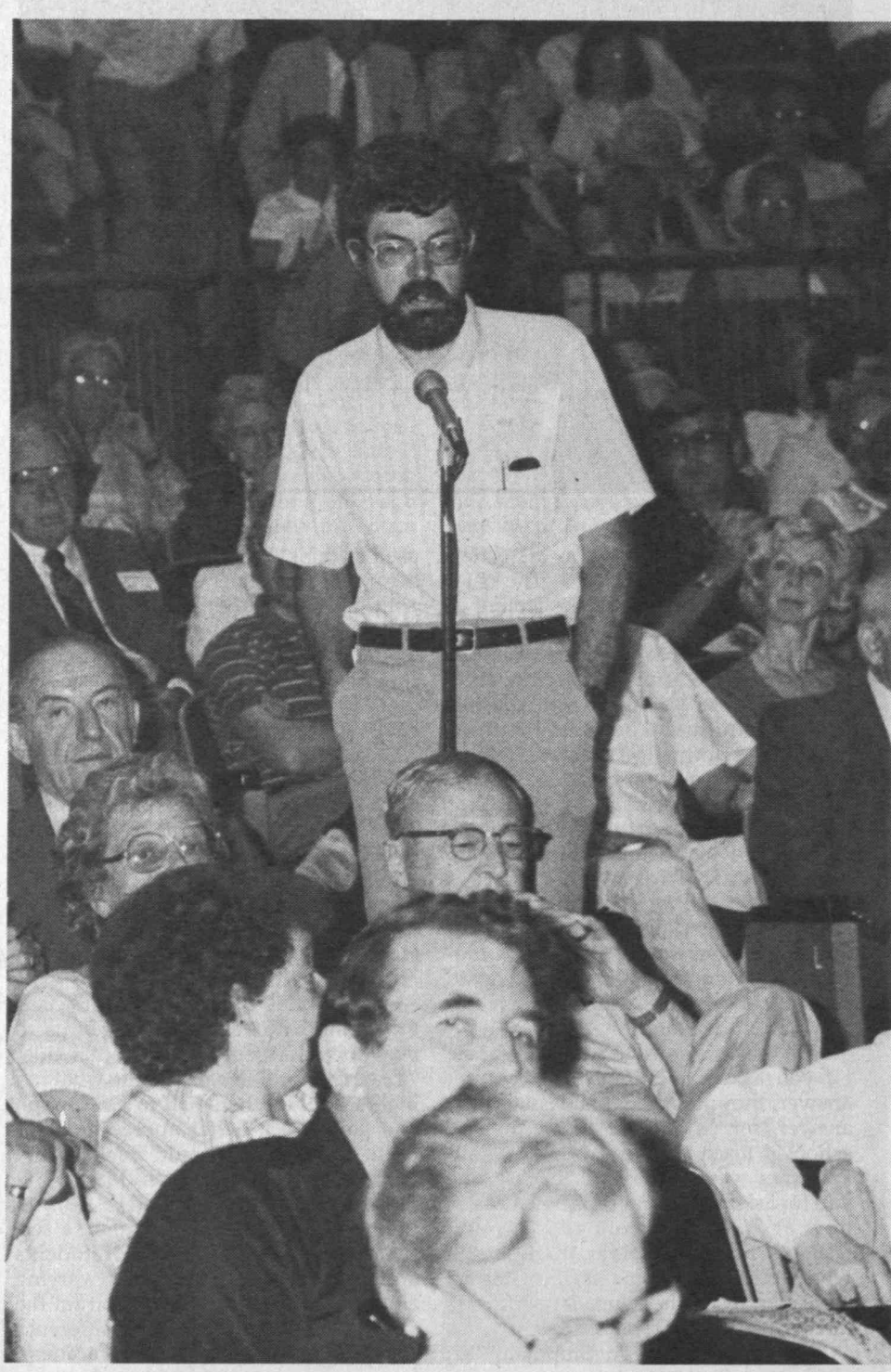
Queen Isabella had to be one of the first venture capitalists, when you think about it. That notion drew a chuckle from the Technology Day 1984 audience when Samuel W. Bodman, Sc.D.'65, used it to open a panel discussion June 7 on entrepreneurship, venture capitalism and the processes of building a successful business.

Judging from the size of the audience on that sizzling hot day, and the way they all stayed through the last of the question-and-answer period, this year's T-Day topic hit alumni where they live, or at least where they have been doing a lot of thinking lately.

Although venture capitalists have been around for a long time, it is only recently that they are talking very much about what they do, Bodman said. And entrepreneurs in their turn have come in for a lot of attention once analysts noticed that small companies, not large corporations, are the big job generators.

More venture capital was vested in 1983 than in the entire previous decade, Bodman said, and big investors, such as insurance companies and retirement funds, are getting into the market. Such rapid growth means that there are now many inexperienced people involved in the venture market, Bodman believes.

Bodman, who is president and chief operating officer of the Fidelity Management & Research Corp., explained how he looks at potential investment. First, he said, check the track records of the people. Then look at their business plan and compare the requirements of the plan with the skills of the people. Do they match? And ask yourself, Can these people maintain a "performance environment?" There is a lot of hiring and firing to be done in setting up a new enterprise; Can these people make the hard decisions?



People, People, and People

Daniel Holland, '58, president of Morgan and Holland Ventures Corp., spoke of launching that firm in 1982. He and five partners assembled a $60-million-

Holland: "Entrepreneurial talent is like pornography: I can't define it, but I know it when I see it."

fund, which he described as representative of today's industry. Twenty-five percent of the capital came from the corporate sector (pension funds, etc.), 30 percent from money markets, and the remaining 45 percent from wealthy families and individual investors.

He says their mode of operation is "slow," they look at 100 to 150 opportunities for every one in which they invest. "We look for three things," Holland said, "One is people, two is people, and three is people!"

His final observation: you will find out early which are the failures; but determining which enterprises will be the solid successes takes a long time.

A Very Rare Bird

It was quite a different start for Analog Devices, a Cambridge firm founded in 1965 by Ray Stata, '57. He launched the company with $100,000, and it ran on "sweat capital" for the first four years before he brought in any additional outside investment.

In this day of instant millionaires, Stata quipped, when the first action of the board of directors of many new companies is to vote the president an $80,000 salary, a car, and credit cards, "a true entrepreneur is a very rare bird." And by true entrepreneur he means someone with a vision of how technology can be developed to meet the needs of a market, plus the talent to realize that vision.

In fact, Stata said, there is now more venture capital available than there are real entrepreneurs to use it, a situation which generates pressure to *create* entrepreneurs. "You take ideas from one place, people from another, mix liberally with venture capital, and hope that what you produce is exciting products and markets."

Thirty percent of the new companies are in trouble, according to Stata, not because they lack good products or promising markets, but through a lack of talent and leadership in management. So what's the best strategy?

Stata said that established companies must become more entrepreneurial. In-

It was standing room only on Technology Day last June 8, when alumni filled Kresge Auditorium to hear about venture capital and entrepreneurship and the Chapel to pay tribute to alumni deceased in 1983-84. Among the Kresge speakers: Ray Stata, '57 (top), chairman of Analog Devices, and Bill Poduska, '59, chairman of Apollo Computer. (Above) Reverend Robert J. O'Donnell, C.S.P., Catholic chaplain at M.I.T., conducted the memorial service.

PHOTOGRAPHS: FRANK REVI '86 AND SARAH SIMON '72

"Ours is a grateful remembering of the wonderful diverse personalities . . . let it orient us to the present and the future as well as the past"

FATHER ROBERT O'DONNELL

stead of limiting the development of new ideas and forcing the mavericks and innovators in their midst to break away and form competing enterprises, existing companies should provide a structure for entrepreneurial subsidiaries that operate autonomously. Having the parent company to lean on, the heads of the entrepreneurial subunits are under much less pressure to be the "Renaissance men" of the business world—they are not obliged to embody absolutely all the skills needed to keep the new enterprise afloat.

Stata speaks from experience. His own company, Analog Devices, set up Analog Devices Enterprises to develop new ideas. He noted that the budgets of the two companies are kept quite separate. Capital generated by Analog Devices is reinvested in the parent company, and outside capital was brought in to finance the offshoot.

Making Millionaires

John Poduska, '59, also bases his views of venture captialism on experience, having founded two venture companies. His most recent project, Apollo Computer, is now four years old, has 1800 employees, and has created some 60 millionaires. His is a Horatio Alger story Poduska believes could only happen in the U.S.

Admitting that it is difficult to manage in a high-risk environment, Poduska urged every entrepreneur to have three plans: plan A, "what you want to do"; plan B, "what to do when things go wrong"; and plan A-plus, "what to do if you get the breaks"—if technology develops faster than you predicted or orders come in faster than you planned.

Unprecedented Opportunities

Following their initial presentations, the panelists fielded a torrent of questions. For openers, How do you develop qualities of an entrepreneur? "Doing it is important," Ray Stata said—"just being in the environment where new ideas are explored."

Reunion '84 was sweltering, but alumni kept cool and festive at events like Tech Night at the Pops and an elegant Class of '34 dinner at the Museum of Fine Arts. Neil Didriksen (top, facing) of the Alumni Association directs Pops-goers to the buses; the pre-concert throng (left center); conductor John Williams (far left); and the enthusiastic audience at Symphony Hall. (Top, right) Alex Blakely, '34 and retired president and chairman of the corporation Howard Johnson with a magnificent backdrop; (center, above) Ed Sieminski, '34 and classmate Po T Ip, who came from Hong Kong for the Reunion. And right, reunion majordomo Joe Martori, associate secretary of the Alumni Association.

Stata also said that a vital skill for the entrepreneur is finding ways of sharing the company's success with talented people. He said this is the time of unprecedented opportunity for talented people, and the entrepreneur who doesn't reward them will lose them.

Daniel Holland remarked that entrepreneurial talent is like pornography: "I can't define it, but I know it when I see it."

How important is financial background? Do you need an M.B.A.? The panelists agreed that an effective CEO is CEO for the entire company, and that means being knowledgeable, though not necessarily a specialist, in all aspects of the operation. Personal contacts are all-important, they said; you must know whom you are dealing with and whom to trust, particularly in those areas where you are not an expert.

Why Not a Human Focus?

One member of the audience pointed out that although all the speakers emphasized the importance of valuing good people, none of the businesses they discussed had a human focus. He questioned the emphasis on high-tech investments in discussions of venture capitalism.

Ray Stata responded that a large segment of the 100 fastest-growing businesses in the U.S. is made up of nontechnical companies like People Express Airlines and Dunkin' Donuts.

It is also true that high-tech industries are generating a lot of capital for reinvestment. Sam Bodman pointed out that it shouldn't surprise anyone that, when looking for investment opportunities, the leaders of these industries stay in the fields they know best.

Judging from the donations to M.I.T. announced at the Technology Day luncheon which followed the panel discussion, (*see page A8*), it is safe to say that a not-inconsiderable portion of the profits of high-tech and entrepreneurial ventures of Institute alumni, at any rate, *is* being invested in people—namely students. □

Reunion Giving Climbs to $8.2 Million

An outpouring of alumni giving—a total of $8.2 million that "took his breath away," said President Paul E. Gray, '54—was the highlight of the Technology Day luncheon on June 8. More than 1,200 alumni and guests—most of them on the campus for reunion activities either before or after Technology Day—were present to cheer.

Gifts totalling $4 million were reported by the major reunion classes:

☐ From the Class of 1959 came $758,000, of which $273,000 was earmarked for its scholarship fund. As the 25th reunion began two days earlier, said gift chairman Robert Muh, President Gray had kidded him—only 18 more hours. "That," said Muh, "was $75,000 ago." Class participation—67 percent—was a record for any 25-year class in the history of the Institute.

☐ The $1,030,500 from the 40-year Class of 1944 was their expression of thanks "for the great contributions of M.I.T. to our personal and professional careers," said reunion gift chairman Edgar P. Eaton, Jr. Of that, $430,000 was for the Class of 1944 Scholarship Fund. Sixty-two percent of the class contributed.

☐ Henry B. Backenstoss, chairman of the Class of 1934 reunion gift, began by recalling his classmates' determination to break a record 25 years ago; at $122,000 they were the first 25-year class to exceed $100,000 mark. Though mellowed by the years, said Backenstoss, his classmates were still out for records, and they had one: a record 77.9-percent participation in a gift of $2.3 million. Furthermore, said Backenstoss, 33 members of the class expect to make bequests totalling $1.25 million.

Robert W. Mann, '50, president of the Alumni Association, announced an unprecedented gift from the Class of 1924 in celebration of its 60th reunion—$4.1 million.

But the horn of plenty was not yet empty. As its senior gift, the Class of 1984 had collected more than $3,500, class president Diane M. Peterson reported, and its members had pledged $13,370 to the Alumni Fund before their fifth reunion. There were also gifts from the ten-year Class of 1974—$35,500—and the five-year Class of 1979—$27,500.

When they graduated, said Henry Backenstoss, '34, reunion gift chairman, his "brash, aggressive classmates had the world by the tail." They still do—to wit, a 50th reunion gift that set a record for participation. Diane Peterson, '84, gave President Paul E. Gray, '54, a record, too: a commitment for over $16,000 from her class by 1989.

No Greater Need Than Scholarships

Responding, President Gray called such alumni generosity "the lifeblood of M.I.T. Without such support," he said, "the Institute would be less than it can be." He noted the emphasis on scholarship funds with satisfaction: "no need is more important than our ability to support the ablest students from all over the world."

In other business at the annual luncheon, President Mann awarded honorary memberships in the Alumni Association to three members of the M.I.T. staff distinguished by their long-time service to the Institute and concern for its students and alumni:

☐ Dorothy L. Bowe, associate director of student financial aid who has been for 20 years "deeply involved in every aspect of student affairs," said Professor Mann.

☐ Loretta H. Mannix, administrative assistant to President Emeritus Julius A. Stratton, '23. Ms. Mannix joined Dr. Stratton in 1957 when he became president, having first come to M.I.T. in 1945 as an administrative assistant in the School of Engineering.

☐ Elizabeth A. Pigott, administrative assistant to President Emeritus James R. Killian, Jr., '26, who has worked with Dr. Killian for her entire 32 years at the Institute.

To complete the luncheon program—and at the same time to complete his service as the first faculty member to be president of the Alumni Association since 1928—Professor Mann turned over his gavel to Mary Frances Wagley, '47, noting that she would be the first woman ever to head the association. ☐

Reunion greetings and good fellowship (clockwise from the top left):
☐ *Warren A. Seamans, director of the M.I.T. Museum, displays his credentials as a new honorary member of the Class of 1935.*
☐ *William J. Hecht, '61, is made honorary member of the Class of 1924 by its president, Donald E. Moore.*
☐ *Kemon Taschiogliou, '49, has the joy of bringing two old friends together: Harold Ottobrini, '48 (left), and John W. Barriger, '49.*
☐ *President Paul E. Gray, '54, greets members of the 50-year Class of 1934.*
☐ *Special congratulations from Marjorie Pierce, '22, to Mary Frances Wagley, '47, new president of the Alumni Association.*

PHOTOGRAPHS: FRANK REVI, '86, CALVIN CAMPBELL AND SHIRLEY PICARDI

Alumni Fund: Closing in on $10 Million

Five-Year Targets Attained in Four Years

Letters, telephone calls, even forget-me-not seeds—they were all the tools of more than 5,000 alumni volunteers whose work for the 1984 Alumni Fund helped spur unprecedented alumni generosity for M.I.T.

The total: $9,434,000 from 27,637 individual donors, making 1983-84 the sixth straight year of donor and dollar growth and the 1984 Alumni Fund the largest in history. Contributions were received from more than half of all alumni with undergraduate degrees and 33 percent of those holding only graduate degrees. Last year's figures were $8,662,000 from 26,800.

Of the total, $1.1 million was designated for student financial aid—up 45 percent from last year in response to a specific plea from President Paul E. Gray, '54. Just under one-third of the 1983-84 gifts were unrestricted as to purpose—and thus may also be used for student aid.

There were more larger gifts in 1983-84 than ever before. More than 8,000 alumni gave $100 or more (up 10 percent from 1982-83), and there was a 13-percent growth in those making gifts of $250 or more. Some 3,000 alumni qualified for membership in the Sustaining Fellows or Great Dome Associates (*see the rosters on the following pages*).

Of the 1983-84 donors, 1,600 were making their first contributions to M.I.T., and 40 percent of these were in the five youngest classes. Typically, it has taken an undergraduate class 10 years for 70 percent of its members to have made at least one gift to the Institute; that time has now been cut in half.

Reviewing these results in the Alumni Fund's 1983-84 annual report, President Gray said they were "simply stunning . . . a solid vote of confidence in M.I.T. by our alumni." Clearly, said Dr. Gray in a letter to James K. Littwitz, '42, chairman of the Alumni Fund Board, "our alumni are prepared to support, in full measure, our efforts to keep M.I.T. at the cutting edge in education and research."

Mr. Littwitz agreed. He ends his two-year term as chairman, he says, "satisfied that our fellow-alumni stand ready to help in every possible way to keep M.I.T. in the forefront of higher education."

In a statement as director of the Alumni Fund, Joseph S. Collins noted that the success in 1983-84 meant that a series of five-year targets adopted for the Alumni Fund in 1979 had been met one year ahead of schedule. Projections called for contributors to increase by 500 per year, but the actual increase has exceeded 1,100; the number of gifts of $100 or more was targeted at 7,500 by 1985 and has now exceeded 8,000; and the value of matching gifts collected by the Institute has grown from $500,000 to more than $1.25 million in four years.

Collins finds "no single reason for this dramatic shift upward in alumni support. Clearly," he said, "the alumni body as a whole feels a strong commitment to the Institute and its leadership." □

M.I.T. Sustaining Fellows as of June 30, 1984

The M.I.T. Sustaining Fellows program was established in 1979 to recognize individuals whose support of the Institute is particularly exemplary. Membership is extended to alumni and other friends of M.I.T. making annual gifts of $2,000 or more for unrestricted purposes, endowment, professorships, or student aid; life membership is offered to donors whose cumulative gifts exceed $25,000. Donors requesting anonymity are not shown.

Founding Life* and Life Members

1908
Mrs. Leo Loeb*
Mr. and Mrs. Harold S. Osborne*

1912
Dr. Jerome C. Hunsaker*

1913
Mr. Julian E. Adler*

1914
Mrs. Vashti L. Magoon*

1915
Mr. C. Ellis Ellicott, Jr.*
Mrs. Edmund R. Stearns*
Mr. Robert Welles*

1916
Mrs. J.B. Carr*
Mr. Barnett D. Gordon*
Mrs. Francis E. Stern*

1917
Mr. and Mrs. Walter J. Beadle*
Mr. A. Raymond Brooks*
Mr. E. P. Brooks*
Mrs. Stanley M. Lane*
Mrs. Richard T. Lyons*
Mrs. William H. McAdams*

1918
Mr. and Mrs. Julian M. Avery*
Mrs. Malcolm J. Baber
Mrs. John W. Kilduff*
Mr. and Mrs. Max Seltzer
Mrs. Harold C. Weber

1919
Mr. Benjamin H. Bristol*
Mr. and Mrs. Royden L. Burbank*
Mr. John L. Riegel*
Mrs. Dean K. Webster, Jr.*

1920
Mr. Henry W. Hills*
Mr. and Mrs. Edwin D. Ryer*
Mr. and Mrs. L. G. Thomas*

1921
Mr. T. B. Davis*
Mr. Sumner Hayward
Mr. Irving D. Jakobson*
Mr. Samuel E. Lunden*
Mr. and Mrs. Edmund J. MacDonald
Mr. Robert L. Moore*
Mr. and Mrs. Antonio Helier Rodriguez*
Mrs. Raymond A. St. Laurent*
Mrs. Arthur G. Wakeman*
Mr. and Mrs. Robert E. Waterman

1922
Mr. and Mrs. Edward L. Bowles*
Mr. Donald F. Carpenter*
Mr. Crawford H. Greenewalt*
Mr. Oscar H. and Mrs. Mary C. Horovitz*
Mr. and Mrs. Albert J. R. Houston*
Mr. H. W. and Mrs. S. Catharine McCurdy*
Mr. Theodore T. Miller*
Miss Marjorie Pierce
Mrs. Thomas H. West*

1923
Mr. and Mrs. Jonathan Y. Ballard*
Mrs. Philip L. Coleman*
Dr. and Mrs. Cecil H. Green*
Mr. Earle A. Griswold*
Mr. and Mrs. Harry Kalker
Mr. Ragnar and Mrs. Margaret Naess*
Mrs. David W. Skinner*
Mr. and Mrs. Robert C. Sprague*
Dr. and Mrs. Julius A. Stratton*
Mr. Chaplin Tyler

1924
Mr. and Mrs. Edward A. Abdun-Nur
Mr. and Mrs. Philip Blanchard*
Mr. and Mrs. Austin G. Cooley*
The Honorable Luis A. Ferre*
Mrs. Edward J. Hanley*
Mrs. Andrew P. Kellogg*
Mr. Herbert W. Kochs
Mr. and Mrs. David A. Meeker
Mr. Paul Tishman*

1925
Mr. John M. Campbell*
Mr. Edward H. de Coningh
Mr. and Mrs. Frederick W. Greer*
Mr. Edward M. Lee
Mr. and Mrs. Samuel R. Spiker*
Mr. and Mrs. Karl R. Van Tassel*
Mr. C. L. Zakhartchenko

1926
Mr. and Mrs. George E. Armington
Mr. and Mrs. Robert T. Dawes*
Mr. and Mrs. William E. P. Doelger*
Mr. George P. Edmonds*
Mr. and Mrs. Eben B. Haskell*
Mr. John B. Jacob
Mr. I. Austin Kelly III*
Dr. and Mrs. J. R. Killian, Jr.*
Mr. John R. Kimberly*
Mr. and Mrs. Henry C. Rickard
Mr. and Mrs. Wm. Crighton Sessions*
Mrs. George Warren Smith*
Prof. and Mrs. Gifford H. Symonds
Mr. and Mrs. James P. Warner*
Mr. and Mrs. John B. Wright*

1927
Mr. S. S. Auchincloss*
Mr. Arthur J. Connell*
Mr. and Mrs. Arthur G. Connolly
Mr. and Mrs. John B. Drisko
Dr. and Mrs. Harold E. Edgerton
Mr. and Mrs. Harold W. Fisher*
Mr. B. Allison Gillies
Mr. William Kaplan

Mr. and Mrs. Thomas A. Knowles
Mr. Frank Massa
Mr. John W. Norris, Sr.*
Mr. Howard W. Page*
Mr. Russell P. Westerhoff*
Mr. and Mrs. Clarence L. Wynd*

1928
Mr. George A. Bernat
Mr. Homer A. Burnell*
Mr. and Mrs. Roland D. Earle
Mr. and Mrs. Tom Garrard*
Mr. Elisha Gray II*
Mrs. Harold L. Hazen*
Mr. and Mrs. Henry N. Lacroix*
Mr. Carl M. Loeb, Jr.*
Mr. and Mrs. George P. Palo
Mrs. Edward J. Poitras*
Mr. and Mrs. Walter J. Smith*
Mr. and Mrs. Abraham Wolf*

1929
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Francis M. Kurtz
William H. Lang
Zen Zuh Li
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Arturo Ponce Canton
Karl E. Schoenherr
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Robert Tonon
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John Skelton Williams
Samuel I. Zack

1923
William P. Allis
Horatio L. Bond
Charles T. Burke
Franklin G. Clement
Edward H. Clendenin
E. Bartlett Cocke
Roger Cutting
Michael Drazen
Harland C. Forbes
John A. Frank
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William B. Greenough, Jr.
David M. Houston
William S. Lalonde, Jr.
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Gladys F. Noble
James A. Pennypacker
Leander H. Poor
Edward C. Rue
Joseph H. Scholtz, Jr.

1924
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James H. Grahame
Allen W. Hawkins
Gordon C. Joyce
Hayden B. Kline
Richard Lamborn
Francis E. Manley
Clarence W. Moore
Donald E. Moore
Wilmot G. Peirce, Jr.
Mark L. Sinnicks
Luang Videt-Yontrakich
John H. Walthall
Helen Gill Welling
Samuel M. Zerkowsky

1925
Alan W. Crowell
L. Patterson Elliott
F. Leroy Foster
Arthur G. Hall
Maxon H. King
Finley B. Laverty
Russell C. Mader
Milton G. Salzman
Max M. Sandfield
Alexander E. Ulmann
William R. Wheeler
Courtenay P. Worthington

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Donald S. Cunningham
William W. Farr
Alfred W. French, Jr.
John A. Gibson
Arthur F. Johnson
Walter E. Lobo
George A. Makaroff
Benjamin Margolin
Charles E. McCulloch
Earl C. McMahon
Morris L. Minsk
Robert W. Sherwood
Joel S. Tompkins
Elmer C. Warren
Richard Whiting
Robert A. Williamson
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Carlton G. Davies
E. Robert de Luccia
Walter F. Fathauer
George D. Fexy
Herbert G. Johnson
Charles Kingsley, Jr.
Gustavo Lobo, Jr.
Paul E. Parker
Herbert Parkinson
Charles A. Sanborn
Helmuth G. R. Schneider
Donald A. Sherman
Jerome L. Spurr
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George I. Chatfield
Chester M. Day
Victor J. Decorte
A. Starke Dempewolff
James Donovan
A. Wentworth Erickson, Jr.
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Lawrence Glassman
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John K. Rouleau
Irl Sandidge, Jr.
Dudley W. Smith
Charles A. Southwick, Jr.
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Karnig S. Dinjian
Arnold W. Ewan
Hyman J. Fine
Ogden Fitzsimons
Romeo H. Guest
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John F. Joyce
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Austin S. Norcross
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Hunter Rouse
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Gregory Smith
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A. Hesselschwerdt, Jr.
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Jacob Millman
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Charles H. Taylor
Thomas Weston

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Edgar Svikis
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H. King Cummings
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Alfred C. Wu

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William A. Verrochi
Michael Witunski

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Ralph H. Berman
Lawrence G. Body
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What and Where Are These Beavers?

Here's a new "Find the Beaver" contest sponsored by Leigh J. Passman, '81. "Two non-alumni domesticated the beaver for the American home," writes Passman. "Who are Joe Connelly and Bob Mosher? Name the distinctive beaver they popularized."

Passman will give $25 to the 1985 Alumni Fund in the name of the respondent whose correct answer bears the earliest postmark; and the respondent will designate the purpose for which the gift is to be used. Send answers to Beaver Contest, Technology Review, Room 10-140, M.I.T., Cambridge, Mass. 02139.

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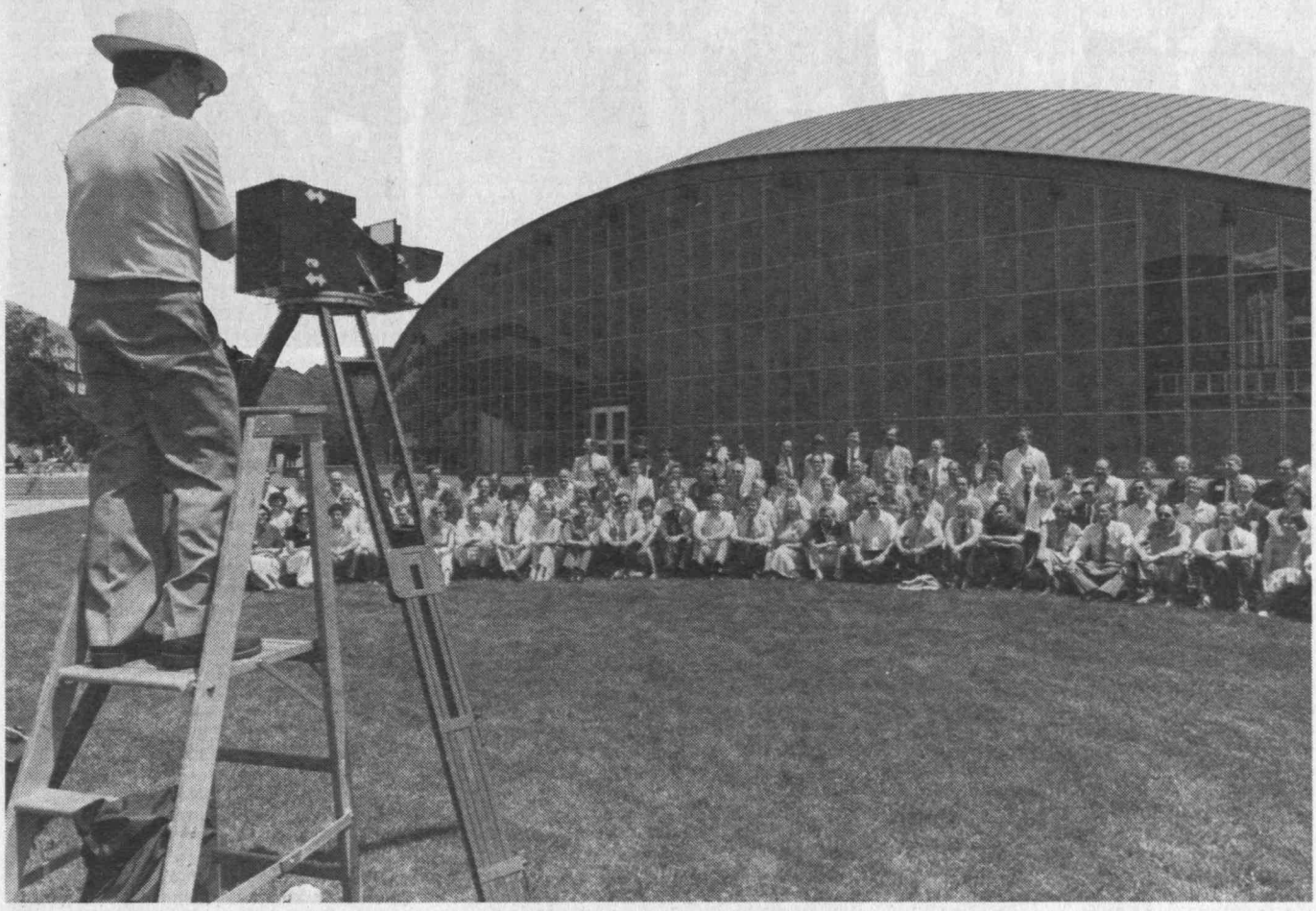
Urban Studies & Planning
Theodore S. Bacon, Jr. '56
William J. Cairns '67
Samuel M. Ellsworth '55
Ahmad Y. Eshmawi '83
Allen G. Gerstenberger '74
R. Alan Melting '69
Barbara Z. Sedlin '60
Abbott L. Stillman '73
M. Walker Wallace '50

Undesignated
Philip A. Le Bar, Jr. '69
William F. Martin '74
Richard S. McCurdy '70
William G. Nemeth '69
Shobha B. Rao '72
Elizabeth J. Yeates '74

Honorary
D. Hugh Darden
James N. Phinney
Walter A. Rosenblith

NEWS FROM YOUR CLASSMATES



05

Frances Maroni writes to say that her father **Gilbert S. Tower** (1905 class secretary), died April 9, 1984 "quietly in his own home at age 99." He was active in Cohasset, Mass. town affairs and was involved in the town's development and planning, speaking out on issues such as sewer treatment, harbor improvements, and housing for the elderly and young couples. "He was Cohasset's man of letters, and we loved his enthusiasm," says Tanna Kasperowicz, former *Cohasset Mariner* editor.

Friend and comrade Arthur Clark remembered Gilbert Tower as "a particularly brilliant and serious man." He was a nationally recognized pioneer in naval architecture and engineering. He was a member of the first class to graduate from M.I.T. with a master's degree in architecture. In 1917, he entered the U.S. Navy and prepared ships for World War I. He was later transferred to M.I.T. as an assistant professor of naval architecture. After the war, he served as a mechanical engineer in the Panama Canal Zone, and in World War II was a naval architect in the navy's office at the Quincy Shipyard, where he stayed until his retirement at age 75.

He also enjoyed updating his antique home, gardening, and music. Mr. Tower leaves his wife, Elizabeth O. (Collier) of Cohasset; a son, Osgood, and his daughter, both of Washington, D.C.; ten grandchildren, and nine great-grandchildren.—*S.K.*

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Warren Glancy and **Walter Muther** attended Technology Day in June. I was not able to be there but would like to hear from those who were.

We have been notified by the Alumni Office that **Alonzo M. Mutersbaugh** died November 18, 1983. He had been ill for the last four years. He is survived by his widow. Our sympathy to her. Please keep in touch—**Rosalind R. Capen**, Acting Secretary, 7 Brackett Point Rd., Biddeford, ME 04005

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On their way from their home in Southport, Conn., to Technology Day and our 70th reunion on June 7, Betty and **Ros Barratt** stopped for me in West Hartford and took me the rest of the way to Cambridge. The first event after registration and a visit to our dormitory rooms was a buffet supper at the Stratton Student Center. Then we were taken by bus to Symphony Hall in Boston, a longer ride than usual because the Massachusetts Ave. bridge was closed to vehicular traffic. Tech Night at the Pops was enjoyable as always. Ros's son, Grant Barratt, '55, joined us there and was with us for the rest of our stay. Next morning I went to the *Technology Review*'s reception for class secretaries. During the reception, two of my for-

Class of 1959 (top), celebrating their 25th reunion in June, gather for a group photo in front of Kresge Auditorium. Franklin Towle, 97 (above), the most senior alumnus to attend Technology Day, represents Class of 1908. **(Photos: Frank Revi, '86)**

Returning to M.I.T. for their 65th reunion, members of Class of 1919 are (left to right): Alan McIntosh, Russell Palmer, William Bogt, Donald Way, Larry Riegel, George Bond, Oscar de Lima, W. O. Langille, and George Michelson.

mer students from my brief period of teaching aeronautics in the twenties greeted me. The Barratts and I then attended the memorial service for alumni who died this past year. Seven of our classmates were among them.

Harold Wilkins joined us for the Alumni Luncheon. He's had a lot of illness in past months, but was much improved and was looking forward to spending a good part of the summer on Cape Cod. The Alumni Association did everything possible to make our reunion a success. Two ladies of the staff were assigned to see that we kept out of trouble, and at the luncheon our banner was in the senior position in the line of the banners of the five-year classes. After the luncheon, Grant Barratt, '55, drove those of us from Connecticut home.

Word came in late June of the death of **Israel H. Lovett** on April 7, 1984. He was a member of the faculty of the University of Missouri for 40 years and had been chairman of the electrical engineering department of its School of Mines at Rolla, Mo. In recent years he had been living in the Sunset Village of the Ozarks in Waynesville, Mo. I hope to have more information on his career in later class news.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

15

"Our lady," **Mimi Plummer Rice**, says the first thing she looks for when the *Review* arrives is "our news." She is now living in a very elegant retirement home. But as much as she enjoys it, she misses the Bronxville, N.Y. style of living that she enjoyed for 52 years. Mimi and her granddaughter came east, from Petaluma, Calif. to Washington, for a DAR Convention, and then on to New York City where she had many reunions with old friends. She has kept the 1915 and 1916 *Technique* yearbooks and is having them rebound. The M.I.T. Museum director asked for her huge 1915 framed diploma, so she sent it to him. Because Mrs. McCormick was a third cousin of Mimi's, the diploma will hang in Mrs. McCormick's room at the museum.

C. Ellis Ellicott, from Baltimore, Md., spent a week in August at Deer Isle, Maine with his whole family and a 40-foot cruising boat. All four generations went sailing and played around, while he sat on the lawn and read. His health is good, he still drives during the day, and he enjoys his dog. . . . **Sol Schneider** has recovered from surgery and a slight stroke and is back in his own home. He hopes shortly to get back into the usual social activities. He is enjoying the class notes and Loring Hall's diary of undergraduate days. Sol also mentions that next year is the BIG 70, and he says those that don't make it will be there in spirit. The 70th Reunion is "food for thought," and if there is interest from some of the gang, perhaps we could make some arrangements. I'd love to have thoughts and feelings from each and every one of you about a 70th reunion!

Joan Pollard Smith-Variz, daughter of **Reginald Flint Pollard** (a chemical engineer at Brown Co. in Berlin, N.H. until his death way back in 1934) and wife of a Tech man says she reads the 1915 news. Joan also reports that her father's sister, Ruth Evelyn Pollard, has been enjoying the account of the field running in the '15 notes, especially since she knew so many of the '15ers. So again, a tribute to **Loring Hall**. Joan's mother, Ruth James Pollard, passed away, and a memorial service was held in Marion. Joan mentions how much her mother enjoyed the 50th reunion at the Coonamesset, which she attended with the Wolcotts. I also stopped in at the Coonamessett (still have an amber bowl with a sterling silver top with my name engraved on it, as a gift to me at that gathering). **Ben Neal**'s daughter, Barbara, and I were along with him at the reunion, and we explored the Cape that weekend. I have many fond recollections of the clambake and of meeting the whole gang at the Coonamessett!

Loring Hall tells me he has been busy this year building a perennial garden—lupine, gallardias, and trillium. And next to the garden (21 varieties in all) is one of the lovliest red bud trees he has ever seen. More of Loring's diary:

May 1, 1912—Had an English exam the first thing this morning. It was not too tough. Got a notice to appear before the Scholarship Committee on May 15. We drilled out of doors for two hours this afternoon. After drill, Doc Freeman and I had lunch at the Union. At 6:30 the M.A.H.S. Club dinner began. Election of officers was held after dessert: president, Paris; vice-president, Navison; secretary-treasurer, C.L. Hall. Several speeches—Major Cole's was the best.

May 2, 1912—Started a six-hour "speed test" in freehand drawing. I chose for my subject a locomotive bell. Finished my "Worcester contour plate" during lunch hour.

May 4, 1912—Got out of German early because our instructor, Herr Meister, had to attend a "Congress of Modern Languages" in Walker building.

May 10, 1912—Had a test in math and a pretty stiff exam in descriptive geometry. Attended chemistry lecture. The new official M.I.T. buttons came out today—cardinal and gray silk rosettes. They are pretty neat. Prescott and Wardwell and I went to the Schubert and saw "Hanky Panky". Great show, good music, funny lines, and pretty girls.

May 17, 1912—Finished my mechanical drawing speed test. In the evening the annual military drill took place. Our outfit, Company B, took first prize. Hooray! In the individual drill category, Casselman won first place and Dunn second. After Major Cole had presented the trophies, we all went to Rogers Building for the traditional bonfire. We threw our collars and gloves on the fire and some fellows threw in their military hats and coats. It was quite a party.

May 22, 1912—Got a letter of introduction to State Senator Vinson, whose signature I have to have on one of my scholarship applications.

May 27, 1912—Final German exam. It took the two hours alloted, but it was not too tough. Mostly translation. Got a new straw hat. Read part of Fiske's *American Revolution*, which is on our summer reading list.

June 11, 1912—Spent the summer selling aluminum cooking utensils door-to-door in Marshfield and in Brockton, Mass. Averaged about $1.00 per hour after expenses.

September 28, 1912—Registered at M.I.T. for sophomore year. Learned I had been awarded a $150 scholarship, so all I had to pay for the first term was $50. Hooray!

September 30, 1912—Started my sophomore year. It was good to get back and see the old faces. Only classes were spherical trigonometry with Professor Passano and German with Herr Erhard. Bought a lot of new books, most of them new, as second-hand ones are scarce. Had dinner with Rube Bassett, Virgil Wardwell, and Herb Whitcomb.

October 1, 1912—Went to the first lecture on "Calculating Machines" by Professor Derr in Engineering Building A. He explained how adding machines work. Went with Wardwell to the "Wall-Eye," more formally known as the Huntington Ave. Theater, where we saw a good movie for 15 cents.

October 2, 1912—Had our first lesson in surveying, under Professor John Howard. Measured a

distance along Commonwealth Avenue. Also had English literature with Professor Robinson and European history for the first time. After classes Seward Highley and I went down to Frost and Adams' and bought some polyphase sliderules for $4.25 apiece. Expensive, but should last for many years. (Mine still works fine in 1984.)

October 3, 1912—Had lunch with Everett Brigham and Horatio Brown. Worked on descriptive geometry for three hours. Bought a new track suit at Horace Partridge's.

October 4, 1912—First lesson in mechanism under Myron Dale. He was very good. At 3:15 Art Nelson and I went out to Tech Field and did some pole vaulting under the instructions of Captain Germain and Frank Kanaly. Had a ride in a 1913 Winton. It is some car!

October 15, 1912—Went to Professor Derr's slide rule lecture with Carlton Eddy. In the World Series today the Red Sox took a beating from the Giants, 11 to 4. They are now tied at three games each.

October 16, 1912—The Red Sox won the World Series from the Giants, 2 to 1. Great excitement in Boston.

November 4, 1912—Had our regular tug-of-war practice today. It is hard work. Elected Percy Werlick captain of the team.

November 5, 1912—In the presidential election today Woodrow Wilson defeated Roosevelt and Taft.

November 6, 1912—Another hard session on the rope this afternoon. The second "convocation" held at M.I.T. today featured Sir William Ramsay, the foremost chemist of the times. He gave a talk on his hobby, the making of a universal language. He characterized it as "modernized chinese." Percy Werlick was elected 1915 class president on the second ballot today.

November 8, 1912—Wow! Some exciting day! It was Field Day and 1915 won it. We came out ahead in all three events: football (20 to 0), relay race (by 1 yard), and tug-of-war (in 1 minute 19 seconds), whereby I won my 1915 numerals. We marched together to the Union, where the sophomore dinner was held. Over 100 were there. Dean Burton and Major Cole were the speakers. Next we went in a body to the Schubert Theater where we saw *Broadway to Paris*, a real good show. The tug-of-war team sat together in Box J. Threw a lot of streamers. After the show we marched to the steps of Rogers Building for the annual shoving match with the freshmen, but it was rather tame. Got home at 11:45. It was quite a day.

November 15, 1912—At the physics lecture today I had to sit beside **Mary Plummer**, our co-ed. The fellows had a lot of fun at my expense. Walked in town with Seward Highley and Dick Hefler.

December 7, 1912—Had lunch at the Union, then went with the rest of the Civil Engineering Society (about 150 strong) to inspect the partially completed Boylston St. subway.

December 9, 1912—Coldest day of the winter, 10 degrees and a fierce wind. Spent most of the day studying German and math with John Hyneman, Seward Highley, and Joe Livermore. At night an all-Tech dinner in honor of founder Rogers' birthday. It is planned to make it an annual function.

Now we have finished Loring's 1912 diary notes, and in forthcoming issues will work on 1913! Many, many thanks, Loring! . . . Keep writing, '15ers. Keep up our spirit and news!—**Joyce E. Brado**, Acting Secretary, 491 Davison Rd., Apt. 9, Lockport, NY 14094

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On Technology Day, Friday June 8, a memorial service was held in the M.I.T. Chapel to commemorate the alumni who had died during the past 12 months, ending in April 1984. The printed service record included the following three members of the Class of 1917, whose deaths had not previously been reported. **Glover M. Birk**, who lived in New Albany, Ind., died in 1981. **Raymond A. Meader**, who lived in San Antonio, Tex., died February 8, 1980. **Harold C. Neumann**, who lived in Des Moines, Iowa, died on an unknown date.

Edward D. Sewall, who lived in Oneida, N.Y., died in 1983. . . . **E. Howard Hutchinson**, who lived in Stuart, Fla., died on April 30, 1984. . . . Colonel **Lawrence L. Clayton**, who was living in a retirement village in Jacksonville, Fla., died on June 20, 1984. His son, Lawrence Jr., has given us the story of his father's army career. In May 1917 he was commissioned in the Coast Artillery. During World War I he served as an anti-aircraft artillery officer in France. After the war he spent three years at M.I.T. as an ROTC instructor. During the 1930s he was assigned to the Signal Corps Laboratory at Fort Monmouth, N.J., where he was the project officer in charge of developing and testing the army's first radar and underwater sonar devices.

In World War II he returned to the Artillery and spent three and one-half years in the Pacific Theater in command of anti-aircraft units during campaigns in New Guinea, the Philippines, and Okinawa. His final assignment was as commanding officer of the Boston Army Base. After he retired from the army in 1953, he became a citrus grower in Florida, living initially in Winter Park and subsequently in Jacksonville.—**Walter J. Beadle**, Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348

18

Last month we reported a short summary of the career of **Herb McNary** who passed away in May last year. Thanks to his good wife Marion, we have news of their son, John, who graduated at our alma mater in June 1954. After receiving a S.B. in chemistry at M.I.T., he studied at the University of Wisconsin and was awarded a doctorate in biochemistry. He became president of the American College in Paris. In 1971 he became president of the American College in Switzerland. A year ago he came back to the United States as vice-president and academic dean of the Mercy College of Detroit.

Charles Watt, retired New England manager for Truscon division of Republic Steel, died June 21, 1984. For the past four years he lived at Carlton Willard Retirement Home in Bedford, Mass. After getting a bachelor's degree in engineering from M.I.T., he went on for a master's in engineering from Harvard University. It was my good fortune to have known Charlie from grammar school on. We both grew up in Lexington, Mass., and so my memory of him goes back 80 or more years. We who knew him will miss him.

A note from Elizabeth (Mrs. **Lester**) **Woodland** tells of the loss of her husband on April 3, 1984 after a lengthy illness. She says, "He was so proud to be an M.I.T. man. He and **Sumner K. Wiley** kept up their friendship all these many years, as well as **Roger B. Wills**, who also was a Melrose citizen.—**Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard Levine**, Assistant Secretary, 519 Washington St. Apt. 15, Brookline, MA 02146

19

The one and only Class of 1919 M.I.T. celebrated its 65th reunion in Cambridge as scheduled on June 7-9 of this year. There were 15 persons in the celebration, nine members of the class and six guests. In attendance were **George P. Bond, Jr.**, Sue and **Oscar A. de Lima**, Florence and **Wilfred A. Langille**, **Alan H. McIntosh** , accompanied by his son's wife Elizabeth, **George Michelson**, **Russell S. Palmer**, **John L. Reigel**, **William H. Vogt, Jr.**, and Barbara and **Donald D. Way**, accompanied by his daughter Sharon and her husband.

We stayed at the Hyatt Regency, located a short distance up the Charles River from the Campus. Don Way and I (with our wives) got there a day early to be on hand to welcome those who came later. We set a focal point of comfortable seats in the lobby near the entrance where stories were retold, pictures taken, and each got as it were, reacquainted. Our plans called for only three major activities—Pops, Technology Day luncheon, and our own class dinner, otherwise each could do as one wished, which pleased everyone there.

Pops was well attended. Due to repairs to Harvard Bridge the bus that took us to Symphony Hall and back to our hotel had to take us for a tour of Cambridge and Back Bay which added to our pleasure.

Our class occupied two large tables at the alumni luncheon. It was held in the air conditioned athletic center and afforded a wonderful chance to visit tables of other classes in our era. We got many compliments for our attendance. The luncheon program was most interesting and gave our class an opportunity to reflect on what has become of "Boston Tech."

The high point perhaps of our 65th was the class dinner, which all attended. We had three class guests—the speaker Mr. and Mrs. Peter H. Richardson, former director of admissions and Dorothy Adler of the Alumni Office. Peter Richardson enlightened us as to the changes that have been made in the Institute since we were students—how students are now accepted and how worthy students are helped financially.

President Way convened a meeting of the class members, at which the treasurer reported a balance of $90 in the class funds, thanks to a check for $50 from **Aubrey P. Ames**. The following members were reelected: president, **Donald R. Way**; class agent, **Royden L. Burbank**; estate secretary, **Benjamin M. Bristol**, secretary and treasurer, **W.O. Langille**. We voted to plan and hold a 70th year reunion.

Due to limited space we have not noted many items of interest to our classmates but will include them in some future issue of the *Review*. Be assured, however, that those who could not attend were remembered during the entire celebration.—**W.O. Langille**, Secretary, Box 144, Gladstone, NJ 07934

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Present on Technology Day in June were Pat and **Buzz Burroughs, Al Burke,** Kay and **Frank Maconi, Phil Waite** and **Elbridge Wason** accompanied by his daughter. Your secretary regrets that he was unable to make it but duly appreciates the fact that Frank Maconi and Buzz Burroughs phoned to check up on this old timer.

It is with sincere regret that I have to tell you of the death of our distinguished classmate **Theron Van Dusen** of 800 N. Ocean Blvd., Delray Beach, Fla. on May 4. He was an engineer for Detroit Edison and a former Birmingham city commissioner. A talented artist, he worked in silver and other metals. An enthusiastic nature lover, he used to paint pictures of birds, especially pelicans (a pelican was his "trademark") for many of his grandchildren. His survivors include his wife, Helen, six sons, two daughters, and no less than 28 grandchildren and five great-grandchildren. He served on the Bloomfield Hills zoning board, was trustee and chairman of the Beaumont Hospital, trustee at Lapeer County Hospital, and a member of the boards of St. Peter's Home for Boys, Camp Oakland, and the Arnold Home.

If you happen to read these notes, you may observe that your secretary has a new address which is not far from his longtime home in Winchester.—**Harold Bugbee,** Secretary, Country Club Heights, 3 Rehabilitation Way, Apt. 702, Woburn, MA 01801

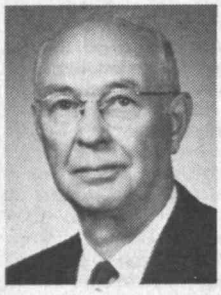
21

It's a beautiful summer day in early July as these notes are being written. Your secretary is sticking

close to Albany this summer so that he can see Betty almost every day. She came over and had lunch with me a few days ago, and it was a happy four hours we had together. Yesterday my daughter and I took a hike in the woods in Rensselaerville following Ten Mile Creek to its source at Myosotis Lake. There were several beautiful waterfalls.

Bob Miller had Sunday dinner with me at Wellspring House on June 11. Bob looked well but told how he missed his wonderful Helen who died last February. He was on Cape Cod in May and attended several meetings of the Coffee Club in Orleans. He also mentioned a May 31 meeting of the "Red Jackets" which included **Don McGuire** and **Whitney Wetherall** and members of other M.I.T. classes. Bob attended Technology Day in Cambridge and at luncheon the class was represented by Maxine and **Cac Clarke**, **Leo Pelkus**, **Don Morse**, **Frank Whelan**, **Whitney Wetherell** and Bob. A greeting card was received by your secretary with warm wishes from those attending Technology Day. Many thanks!

Two alumni who had read in the July *Review* of my move to Albany wrote to me. **Irving Jakobson** wrote a very warm note expressing sorrow that Betty and I were now living in separate establishments. He and Ruth sent best wishes, reported they are both in fine shape, and are glad they are now living in a smaller house in Glen Cove. Said he, "It's a lot less work, and being all on one floor eliminates the stair climbing." Don Green, '26, wrote from Westfield, N.J. that he was sorry Betty had had to go into a nursing home. For many years, Don and I and **Joe Wenick** (deceased) and Ray Brooks, '17, used to get together twice a year to have lunch. Those luncheon meetings were fun.



S. W. Freese

Last month's issue of the *Review* contained a class note covering the address at a Texas meeting of the Newcomen Society on the history of the firm of Freese and Nichols. A recent news release reported that **Simon W. Freese** has been elected an honorary member of the American Society of Civil Engineers, one of the top honors given by the society. Simon will be honored at the ASCE annual meeting to be held at the San Francisco Hilton Hotel on October 3, 1984. The official ASCE biography describes Simon Freese as "Mr. Water," a name given him by colleagues for his extensive role in the development of water resources for Texas. Congratulations! . . . Another classmate honored this year was assistant secretary **Sam Lunden** who this past January was called to appear before the Los Angeles board of supervisors for the presentation of a beautiful document of commendation for his contributions to the architecture of Los Angeles. Sam designed many buildings in Los Angeles and was also the inventor of a conductive pad and system for discharging static charges in hospital operating rooms. Sam is the recipient of many other awards. He and Leila are spending the summer at their South Dennis cottage on Cape Cod. . . . **Bill Sherry** writes: "Margaret and I were saddened to learn of Helen Miller's death. She was a lovely girl. Our class of 1921 had many members who showed good judgment in their selection of partners for life. This includes you and Bob."

I learned from Bob Miller that **Helen St. Laurent** did not attend Technology Day because she was recovering from a cataract operation in late April. Maxine and **Cac Clarke** stopped in at Manchester, Conn. on their way home from Cambridge. Helen is doing fine, plans to leave for her summer home in Center Lovell, Maine mid-July and spend a long summer there. She will see Theona and **Al Genaske** while she is in Maine. Theona has had several strokes so the Genaskes have quit going to Florida winters and stick close to home.

One death was reported this month: Vice-admiral **Homer N. Wallin** of Seattle, Wash. on March 6, 1984.—**Sumner Hayward**, Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 12203; **Joseph D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015.

22

The editor apologizes for a printing error in the July 1984 '22 class column: "painter and poet" was intended to refer to **Zen Zu Li**. **Walt Saunders** wrote to disclaim the title.

Those of us in attendance at lunch on Technology Day, June 8 had the pleasure of making personal acquaintance with Professor Philip S. Khoury the present occupant of the Class of 1922 Career Development Chair. "Us" were **Buck Eacker**, **Bill Gray**, **Oscar Horovitz**, **Marjorie Pierce**, **Win Potter**, **Randy Myer**, **Ted Miller**, and your secretary. Those of the class who stayed away from the luncheon avoided, in the writer's opinion, the poorest Technology Day luncheon served in the last 50 years. And for $13. The rest of the proceedings were perfunctory: installation of the new alumni association president, announcement of gifts, introduction of three ladies to honorary membership, all with appropriate remarks.

Abbott L. Johnson last June received recognition of his 52 years of personal commitment to aviation in Muncie and Delaware County, Ind. and was made honorary, lifetime member of the Delaware County Airport Authority. The occasion was detailed in a long article in *The Muncie Star* June 9. Abbott was honored at a luncheon on June 8 at the Johnson Airport Restaurant. He was presented with a resolution by the board of commissioners of the County of Delaware giving in detail all that he has done since 1928 to bring the airport to its present fine status. At the same meeting, the Federal Aviation Administration presented him with a certificate of recognition honoring him for his "devotion and active involvement during an outstanding career [which] contributed significantly to the advancement of aviation." Abbott was the first Delaware County resident to qualify for a private pilot's license, making his first solo flight on September 19, 1929. His early interest in flying resulted in his being appointed chairman of the first aviation committee of the Muncie Chamber of Commerce in 1928. Our congratulations to Abbott on these belated recognitions.

Don Carpenter suffered a stroke last April, but at the time of writing these notes in mid July he was making good progress at home. I'm sure he would enjoy hearing from classmates. His address is Box 611, Mendenhall, PA 19357. . . . The publication *Seattle*, printed earlier this year by the Port of Seattle, pays tribute to our classmate **"Mac" McCurdy**: "As a permanent reminder of Seattle maritime heritage, one name stands out: Horace W. McCurdy. From grants established by this second generation native son, two volumes of *The H.W. McCurdy Marine History of the Pacific Northwest* were produced from Seattle Historical Society manuscripts, covering the years 1896-1976. In word and picture, the developing maritime events and the people involved are covered, continuing the original classic of 1895 known as Lewis and Dryden's *Marine History of the Pacific Northwest*. McCurdy is now a retired shipbuilder of note (Puget Sound Bridge and Dredging—later Drydock Co., which became Lockheed in the fifties), and he is still involved as a marine industrialist on a reduced scale. Without McCurdy's devoted interest in the maritime world and without his generous support, there would only be scattered records of our maritime past."

Word reaches us that **Norman L. Apollonio** died several years ago, probably in Garden Valley, Calif. **Conrad E. Ronneberg**, who was a graduate student, died March 29, 1984 in Medford, Ore. The 1967 *Alumni Register* shows that Dr. Ronneberg had been chairman, Physical Science, Dennison University in Ohio. No details as to their families are available.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

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Class representation at the Alumni Luncheon was quite sparse: **Julius Stratton**, Elizabeth and **Howard Lockhart**, **Conchita Pearson**, and your secretary-treasurer. . . . **Ray Meekins** writes, "I'll soon be 83 and though I admit to having slowed down, I stay fairly active." . . . **Douglas Alexander** died December 18, 1983. He studied business and engineering administration while at the Institute and became a corporation executive. His career was as secretary of Singer Manufacturing Co., on Broadway, New York City. . . . **William Merrill** died, probably sometime in 1980 or 1981. The Alumni Records Office gives no exact date. He graduated with our class in chemical engineering and became an insurance executive and a chartered underwriter with Penn Mutual Life Insurance Co. of New York City. His hobbies were theater and bridge. Upon retirement he became a volunteer worker in the Jewish Home and Hospital for the Aged.

Edwin Richards died October 23, 1982. He graduated with our class in metallurgy and materials science. He began his career in 1923 with the Illinois Steel Co. of South Chicago, then went with the Monterrey Steel Co., Monterrey, Mexico in 1930, then became open-hearth superintendent for the Cia Fundidora de Fierro y Acerode, Monterrey, Mexico in 1933. He returned to the United States in 1936 to become assistant superintendent for the Carnegie-Illinois Steel Corp. in Chicago until 1942, then superintendent of open-hearth and foundry department of the Geneva Steel Co. of Geneva, Utah, until 1944. He became division superintendent of that company in 1954 and later superintendent of open-hearth and foundry department of the Acme Steel Co. of Chicago in 1957 and engineer for Koppers Co., Inc. of Pittsburgh.

Pierce Van Alstyne died March 30, 1984. He attended courses in electrical engineering with our class and received his B.S. degree from the University of Wisconsin and his L.L.B. degree from Benton College of Law, St. Louis. For 30 years he was area highway engineer, U.S. Indian Service, a registered civil engineer and land surveyor in Montana and Missouri. In 1933 he received the General Motors Better Highway Award for outstanding recommendations on how to build and finance highways in Montana. Also, he received a commendable senior award from the Department of Interior for work performed. He served in U.S. Navy in World War I. His hobbies were horseback riding, hunting, fishing, and trailering.

Yu Hsiang Woo died sometime in 1961. He graduated with our class in electrical engineering. He returned to China and became associated with Kang Tu and Co. in Shanghai. In 1946 he was engaged in liquidation of German properties for the Alien Property Administration, Shanghai. His son Leonard now is studying for a Ph.D. at the University of Arizona.—**Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA.

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Our unforgettable 60th reunion, based at the Royal Sonesta Hotel in Cambridge, is now but a

memory. Attending were: Mary and **John Fitch**, **George Anderson**, Eleanor and **Phil Bates**, **Frank Billings**, Marie and **Eric Brater**, **Don Fife**, **Rock Hereford**, Jean and **Tom Johnson**, **Gordon Joyce**, Edith and **George Knight**, Dorothy and **Ray Lehrer**, **Jack Lurie**, **Don Moore**, Etie and **Gene Quirin**, **Al Roig**, Louise and **Paul Schreiber**, **Dick Shea**, Grace and **Stringer Sinnicks**, **Herb Stewart**, **Henry Tanck**, **Sam Zerkowsky**, Helen and **Irwin Sizer**, Olive and **Bill Hecht** and **Russ Ambach**.

Don Moore's letter is an excellent report on our activities. We had an early start at 9 a.m. on Thursday, July 7, when **Del Kendall** and **Herb Stewart** staged a tennis match on the Dupont Courts. They vow to be the *first* and *only* class to so perform on a 60th reunion. Are there any disclaimers? The committee had hoped for a larger attendance and the Alumni Association extrapolation of records indicated an attendance of 60. However, at least 25 cards, notes, and letters expressed disappointment at being unable to attend, several because of health problems, but all signifying hearty well wishes and success. The McCormick Hall courtyard was very pleasant on a hot day for the president's reception. **Dick Shea**, our entertainment chairman, made an excellent choice of the Sandwich Glass Museum and Heritage Plantations on Cape Cod. The air-conditioned bus was comfortable, but the many miles of Southeast Expressway repairs delayed passage.

Thirty-two sat down at the new Westin Hotel for our final banquet with our guests, honorary members Professor **Irwin Sizer** and **Bill Hecht** and their wives. Professor Sizer, our speaker, offered some sage advice on nutrition, his field of expertise. The new officers for the next five years were railroaded through, and all were bussed back to the Sonesta. A new directory of class members is available by mailing a card to your secretary.

We were saddened to learn of the death of Mrs. Paul J. Cardinal, wife of **Paul Cardinal**. Lorene was as much, if not more, of an enthusiast at class gatherings than Paul, and we will miss her. . . . A reply to an alumni reminder indicates that **George H. Holmes, Jr.** died February 27, 1984 in Paradise, Calif. He was awarded an S.B. in mining engineering, one of the sparsely enrolled courses, but he remained in his chosen field until retirement. After becoming a superintendent, mine operator, mining engineer with the U.S. Bureau of Mines, he became a consultant and issued a number of reports. He was a registered professional mining engineer. . . . **Robert L. Morton, Jr.** passed away in February 1984, apparently in St. Louis, Mo. He earned his S.B. in electrical engineering and spent his career in that industry. He became chief engineer and then vice-president of Valley Electric Corp., St. Louis. His record indicates that he spent some time in Pensacola, Fla.

Howard B. Stevens died in New Jersey on April 17, 1984. He registered with our class in the electrical engineering course and joined the New York City Department of Public Works. He was a captain in the U.S. Naval Reserve and became supervisor of Naval Operations. . . . The return of a questionnaire in April 1984, noted that **Jerome J. Taylor** had passed on November 10, 1983, probably in Detroit, Mich. He graduated in electrical engineering and apparently joined Detroit Edison as an electrical engineer. In 1967 and 1975, he listed Michigan addresses. He was on the 150-pound crew for three years.

Al Roig has an excellent camera and took a few group pictures, which I believe would be available from Al's negatives. Kindly advise your secretary.—Co-secretaries: **Russ Ambach**, 216 St. Paul St., Brookline, MA 02146; **Dick Shea**, 7 Berkley St., South Yarmouth, MA 02664

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The class was well represented at the Technology Day luncheon on June 8. Your secretary was joined by **Jim Howard**, **Ed McLaughlin**, **Frank Mulcahy**, **Milt Salzman**, and **Sam Spiker**. **Joe Martori**, honorary class member and associate secretary of the Alumni Association, was able to take time from his always busy schedule and join us for the luncheon. There was talk about the 60th reunion, and hopefully by the time you read these notes more reunion information will have reached you. Milt brought us the saddening news that his wife Lil had passed away a few weeks earlier following a long illness.

A note from **Anthony Tsongas** tells about the traveling done by him and his wife Bruna. In September 1983 they took a two-week charter bus tour of "all Italy" touching Milan, Venice, Naples, Rome, Pompei, Capri, and Florence. The trip was interesting but fast and tiresome. For September 1984 they plan a four-week trip to Greece with visits to Peloponesus and Delphi with a cruise through the Aegean Sea stopping at Mykonos, Santorini, Crete, and Rhodes.

Word of the passing of three classmates more than a year ago has been slow reaching us. **Howell C. Rice** died in Lexington, Mass. on January 25, 1983, and **Wilder E. Perkins** passed away in Newfoundland, N.J. in February 1983. **Roger Ward** died at Merritt Island, Fla. on August 1, 1983. Roger had kept us well informed of his many activities and worldwide travels. His last letter of several years ago indicated his health was failing. . . . More recently, **John R. Robertson** died in Houston, Tex. on May 4, 1984. . . . A news clipping from the *Boston Globe* noted **Donald J. McNeil** died at the Jamaica Plain Veterans Administration Hospital on May 24, 1984. Don had joined the navy at age 15 and served during World War I as a radio operator. Following his service he completed high school and joined our class at the Institute. He worked for several years with the New England Telephone Co. He was later employed by several Boston advertising agencies.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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A note from **Bob Sherwood**: "Early in May I fell in a parking lot and wound up with four cracked ribs and fractured right kneecap. All seems to be going well and expect to be normal again in about two more weeks. Looking forward to our 60th reunion-Chatham Bars again?" (Present plans are for a repeat at Chatham Bars although they are not finalized as yet.) . . . **Henry W. Jones** reports: "Continue as founding trustee (1967) of the Community College of Philadelphia, director of Blue Cross of Greater Philadelphia, and director of Family Service. Where is **Mark Greer** living now?" (At our 57th mini-reunion which Mark attended he was still listed at 34 Hampshire Rd., Madison, CT 06443.)

A notice advises of the passing on January 15 of **Robert A. Cunningham**, who is survived by his wife. Her address is Box 123, RFD 1, Kennedyville, MD 21645. . . . **Merton L. Gilbert**'s widow, Norma, advises of his death on April 18. Her address is Box 104, Clio, MI 48420. . . . A letter from Michael E. Ash, '59, of 16 Baskin Rd., Lexington, MA 02173, informs us of the death of his father **Maurice L. Ash, Jr.** on May 29 at the age of 79. Maurice, who was in ROTC at M.I.T., served for many years in the Army Ordnance Corps as a reserve officer and was on active duty during World War II. During the Korean War he served in Japan, then returned to work in the Chicago Ordinance District. He was retired in Florida for 24 years, and is survived by his wife of almost 50 years, May Carling Ash, four children, nine grandchildren, and his sister. His deceased brother Edward A. Ash attended M.I.T., Class of '22.

The *Middleboro Gazette* of May 17 listed the death on May 13 at Fort Lauderdale, Fla. of **George W. Breck**. He had been employed as an electronics engineer by Thomas A. Edison Industries, Bendix Aviation, and Raytheon. George, a direct descendant of Samuel Eddy, was president for more than 20 years of the Eddy Family Association and Eddy Family Homestead. He is survived by his widow, Sylvia, at Box 354, Duxbury, MA 02332, and by two daughters and a brother. . . . A number of western Massachusetts newspapers published notice of the death on May 23 of **Alfred W. Gass** of 638 Colrain Rd., Greenfield, Mass. He had been an extensive designer and builder of commercial and industrial buildings in western Massachusetts. By chance of business negotiations, I met Al again some years ago, and through him and his wife Elizabeth became an aficionado of Mexico where we have vacationed almost yearly since. He is survived by his wife, two sons, a daughter, 12 grandchildren and four great-grandchildren.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

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At least two of our prominent classmates are still hard at work professionally. The *Oil and Gas Journal* of May 28, 1984 carries a technical paper by **Bill Hurst** on the drainage of oil and gas across lease lines. Bill is a petroleum engineer of wide renown and perhaps one of the few of us who consistently uses his mathematical background as a working tool. Bill has written several books on his field of expertise and is the recipient of some very distinguished honors.

Jim Donovan is president of Artisan Industries Inc., a company that designs and builds high grade equipment for the chemical and related industries. The business was established in 1934 by Jim and **Ralph Jope** (deceased 1965). The 50th anniversary of the firm is being celebrated this year. Jim never tells us much about himself so, where he is concerned, we must rely on other sources. We do know that he has and has had important outside activities. On June 29 he was given a very nice reception on the occasion of his retirement from the Massachusetts Board of Registration of Professional Engineers. He was appointed to the post by the then governor, Francis W. Sargent, '39, and served for 20 years.

Jim does tell us about other classmates. He had a talk with Claudia and **Morey Klegerman** in mid June and they, in turn, said they were planning to visit **Ed Ure** in a few days.

With regret we must report the deaths of two classmates: Capt. **Frederic D. Riley, Jr.** (U.S. Navy, retired) died on June 9, 1984. We were notified of this in a letter from his son, Philip, who also mentioned that his dad had fond memories of student days and had continued his support and interest in M.I.T. throughout his life. Fred graduated in Course XV, business and engineering administration. Our record shows that he held administration positions in the gas and electric service business in the earlier years of his professional life then entered the U.S. Navy and there remained until his retirement with the rank of captain. . . . **David R. Wiggam** died at his home on March 29, 1984. David was a graduate of Purdue University and came to M.I.T. for his graduate work. He received his S.M. degree in Course X. An obituary notice in the *Hercules*, Vol. 30, No. 6 describes David's professional career at Hercules Powder Co., where he was director of development of the Cellulose Products Department. A number of important product developments were attributed directly to his efforts and influence. . . . To the families of these classmates we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Our 55th Reunion, held at Chatham Bars Inn and M.I.T. campus, has joined the pages of history without making big ripples. The combined attendance between the Cape and M.I.T. was slightly over 50 persons, consisting of members, their wives, and a few widows. On Tuesday,

June 5, when **Frank Mead** and Mary arrived at Chatham Bars, they brought with them the sad news that Joan, wife of **Wally Gale** had passed away a few days before. Most of those attending the reunion knew her and Wally very well, and we all felt sorry to lose such a dear friend. The Gales have been very active in our class activities and M.I.T. affairs, having attended practically all the reunions and participated in most all Committee Meetings at the M.I.T. Faculty Club prior to major 5-year reunions, except in recent years due to Joan's delicate health condition. I am sure we all will miss her.

Those who attended the Cape portion of the reunion, enjoyed three days of relaxation and socialization, with very little planned activities, except for a lobster cookout and our formal dinner Wednesday evening. After dinner, our president, **Bill Bowie** held a brief business meeting at which time Mrs. **James (Teddie) Fahey** presented a check for over $1,200 consisting of contributions made in memory of her husband to be presented to the Alumni Fund as a memorial scholarship. **Bill Baumrucker**, chairman of the nominating committee, presented a slate of candidates for class offices for the next five years, as follows: president, **J. Russell Clark** of Dallas, Tex.; vice-president, **L.R. (Bill) Aldrich, Jr.** of Billings, Mont.; treasurer, **Joseph L. Speyer** of Newton Center, Mass.; and secretary, **Karnig S. Dinjian** of Boca Raton, Fla. The nominees were seconded and elected unanimously.

Those who traveled more than 500 miles to attend the reunion were: Mary and **Murry Brimberg** from Silver Spring, Md.; Dorothy and **J. Russell Clark** from Dalllas, Tex.; Marion and **Earl Erickson** from Burlingham, Calif.; and Marion and **Robert Pride** from North Palm Beach, Fla. A vote of thanks and appreciation is hereby extended to our 55th reunion general chairman, **Jerry Gardner** and his new bride, former Ellie Horwitz Zeghera, who worked so hard to make our reunion a success. Similarly, the class of 1929 would like to thank our retiring president, **Bill Bowie**, of Olmstedville, N.Y. and his wife Sally for carrying out the duties of his office so efficiently and conscientiously for five years. They traveled hundreds of miles from their home to M.I.T. to conduct committee meetings whenever needed. **Sidney Darlington** of Durham, N.H. was awarded an honorary doctor of science degree by the University of New Hampshire in May 1984. . . . **Mark W. Libbey** of Orlando, Fla. has been in three hospitals and nursing homes recently and he is at a retirement center at the present time. . . . **Edwin H. Perkins** of Georgetown, Mass. has a busy schedule of retirement life. He is an educational officer for District 18, U.S. Power Squadron, chaplain of Charles C. Dame Masonic Lodge in Georgetown, treasurer of Eastern Star Chapter 176 and treasurer of Georgetown Rainbow Assembly 98. Whatever leisure time he has left, he goes sailing. . . . I have a note from Florence, wife of **Ted Malmstrom** of Honolulu, Hawaii. "We will be thinking of the class of 1929 celebrating the 55th reunion. We celebrated our 50th wedding anniversary on March 3. Our daughters, their husbands, and my neice and her husband had a lovely party at the Carusow Club. Unfortunately, the night before I fell and fractured my right wrist. I attended the party, but my cast was up past my elbow. Our oldest granddaughter, Kathy, was married December 4. Now we are waiting for great-grandchildren. Time flies by! Thanks for Ted's birthday card. Best wishes to all."

Last year, **Bill Bowie** received a letter from Mary Kyger, assistant director of the Alumni Fund, explaining the recently organized matching gifts program from the senior classes (50 years or older) with fifth and tenth reunion classes. Bill and I went to see Ms. Kyger, who explained that our class members did not have to pay more to the Alumni Fund to sponsor the program. Part of our contributions will be credited to the class of 1979 5th Reunion Gift for any contributions increase of $25 or more from members of Class of 1979. We accepted. We received a letter of appreciation from Brenda Hambleton, chairperson of 1979 5th Reunion Gift, that their class had earned $12,600 from the matching gift program and the class raised a total of $21,000 in all.

Richard E. Bolton of Westmount, Quebec, Canada, who attended the 55th reunion at the Cape writes: "I must thank you and all the members of the class of 1929 for the wonderful welcome and hospitality extended to an unknown foreigner who turned up after 55 years. It was great fun and I enjoyed every minute of it, particularly because the ladies were so kind and helpful in making me feel at home. I must mention **'Fritz' Meissner**, whose quick wit, intellect, and charm combined to make an hour in his company a memorable event. Please, if any of you find yourselves near here, I shall expect to hear from you. My phone is (514) 935-7873. When I was in Boston, I wanted to see the Rogers Building. I drove along the Esplanade, found the Harvard Bridge and Massachusetts Ave. with a mile-long construction ahead, so I gave it up. Someday I shall fly down and see the new Rogers Building, Beacon Hill, Back Bay, remembering my good friends, **"Jimmy" (J. Gordon) Carr, Jack Wheelright, Nat Saltonstall** and **Susan Mellon**. Susie was killed driving an ambulance for the U.S. Army in Sicily and has an architectural scholarship established in her memory to commemorate her bravery."

I regret to announce the death of the following members: **William M. Harris** of Venice, Fla. on March 7, 1984; **Robert W. Gray, Jr.** of West Hartford, Conn. on April 27, 1984; and **Walter F. Burke** of Rancho La Costa, Calif. on May 1, 1984. Mr. Gray was the chairman of the board, Gray and Prion Machine Co., Bloomfield, Conn. He has a son, Robert W. Gray III, M.I.T. '57. Walter F. Burke led the Mercury and Gemini space programs at the McDonnell Douglas Corp. He joined the McDonnell Aircraft in St. Louis in 1945. In 1960, he was named vice-president and general manager of Project Mercury. In 1966, he became president of McDonnell Douglas Astronaumics. He is survived by his wife and a daughter.—**Karnig S. Dingian**, Secretary, P.O. Box 83, Arlington, MA 02174

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Every class secretary dreads the time he may incorrectly report a death—a monumental boo-boo. This happened for me when I reported the death of **Tom O'Connor**, who is alive and in good health. I will explain fully in the next issue.

This month we have reports from our two classmates with homophonic names, **Ed Pritchard** and **Charles Prichard**. After graduating in Course VIA, Ed studied abroad on a Swope Fellowship and then returned to M.I.T. as a research associate in electrical engineering. Thereafter, he worked for a variety of different organizations including Arma Corp., Tennessee Eastman, R.C.A., and Lockheed Electronics Co. More recently he was deputy project manager of a Department of Defense tri-service, long-range tactical communications project from which he retired in 1977. The Pritchard's retirement home is in Pocasset on Cape Cod. They have a son who is a physics professor at M.I.T. and a daughter who is a computer programmer in London. Their extensive travel program includes annual winter visits to Martinique and spring visits to their daughter and her family in England. . . . **Charles Prichard** came to M.I.T. after attending Dartmouth for two years. He spent much of his career managing gas and electric companies: he has served as president of the Nantucket Electric Co., the Manchester, Mass., Electric Co., and Gas Service Inc., which serves Nashua, Keene, and Laconia, N.H. His memberships include the New England Gas Association, American Gas Association and New England Guild of Gas Managers. He was formerly president of the Chamber of Commerce in Nashua, where he now lives.

Recently I received a brief communication from **C. Thurston Ramsey**, whom I have not heard from during my 24-year tenure as class secretary. He reports that he has been long retired, after a career with Pan American in engineering, operations and administration. He and his wife now live in Melbourne, Fla. . . . Hilda and **Earl Ferguson** celebrated their 50th wedding anniversary last April 28 at their home in Glen Ridge, N.J., at a party for 60 people arranged by their daughter and son-in-law. Earl is a retired assistant vice-president of New York Telephone Co. and is active with the Telephone Pioneers. Hilda is an award-winning flower arranger and a painter whose works have been displayed in local art exhibits. . . . **Irvine E. (Ted) Ross** retired in 1969 after a career in electrical engineering. He and Betty live in Fort Wayne, Ind., where he keeps busy in a variety of church and civic activities. New jobs include membership on the Mayor's Commission on Emergency Services and the allocation panel of the Allen County United Way. The Rosses have a son who works in Silver Springs, Md., and from time to time combine visits to their son and to **Irving Dow**, who is also in Silver Springs. They recently visited **Myron Smith**, who is a widower living in Maine in a "picture-book home on Lake Sebago."

We have received a notice of the death of **John Moriaty** in Port Arthur, Texas, on March 3, 1984. After graduating from M.I.T., John worked briefly at Bell Laboratories before joining Gulf Oil in 1935. During World War II he served as radar officer and executive officer of an anti-aircraft artillery group. He was awarded a Bronze Star for his wartime activities. After the war his work involved considerable travel, including electrical design work for a Gulf refinery in Italy, survey of electrical damage after a refinery fire in Venezuela, trouble-shooting at the Gulf Oil of Canada Point Tupper refinery, and electrical design of a fertilizer plant in Korea and a refinery in Spain. After retiring from Gulf in 1973, he continued to live in Port Arthur, hunting and fishing and delivering "meals on wheels" to elderly shut-ins. He is survived by his wife, Etta, a son, John David, a daughter, Gail, and grandaughter, Laura.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488.

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William J. Hallahan reports that he is "still with Fay, Spofford, and Thorndike but with a very low profile as consultant and director. . . . **Parker Dunn** reports, "Although I retired in 1975, I still consult on a part-time basis for Kerr McGee Chemical Corp. . . . From Franklin Pierce Law Center: "**Kenneth J. Germeshausen**, a member of our board, an inventor, an industrialist, and a founder of EG&G, has contributed especially generously. The law center board has decided to name a new center for the law of innovation and entrepreneurship after Mr. Germeshausen."

Claude Fletcher Machen, whose new address is 461 South Creek Dr., Osprey, FL 33559, writes, "Jean and I continue in good health (knock on wood) and spirits (except on days when the golf ball won't seem to go in the hole.) We saw Polly and **Ken Germeshausen** a couple of times this winter and were very happy to learn that the '31 Alaska cruise was such a great success. We very much enjoyed our scenic tour of the Oregon and Washington coasts at about the same time. This year we're gearing up for a trip to China in late September. Lindblad recommends coming with lots of stamina and a not-too-demanding approach to accomodations! We're really looking forward to it. [We can second the comment on "stamina" but found the accommodations quite good.—*Secretary*] We were very sorry to hear about **Ducky Graham** and his wife. We are leaving next Thursday for our summer in New Hampshire and we're planning a couple of days at EPCOT on the way. We understand the China exhibit is outstanding." Claude also sent a clip-

ping about **Don Holden** from the *Newport News* (Virginia). Don has retired as board chairman of Newport News Shipbuilding after 36 years. He was recently honored at a dinner in Richmond applauding his 13-year service as an advocate of Virginia's private colleges and universities. Educators and politicians praised him as the "father" of Virginia's history-making tuition assistance grants, which have helped 98,501 students in 11 years to attend independent colleges in Virginia. Don and his wife, the former Eleanor Watson, moved to Charlottesville from Newport News in 1970 after he was chosen director of the newly-formed council of independent colleges. Moving to Virginia after graduation, he worked for the Virginia Electric and Power Co. in Williamsburg before becoming a shipyard draftsman in 1934. For the next 36 years he moved steadily up from chief engineer to president and then chairman of the Newport News yard.

Jack Parker writes, "After several years of cruises, Jane and I have settled down here in Chapel Hill, N.C., where we are most of the time, except for several weeks in the summer at Figure Eight Island. Three of our grandchildren enter college this fall. We enjoyed seeing former M.I.T. classmates (in the M. Arch. program) Bill Reed, and his wife Guiliana, who stopped by on their way north from Florida last summer. Jim Webb, who was in the MGP program, lives near us and is a frequent visitor." . . . Jack also informs us of the death of **Frederic W. Nordsiek** sometime in September 1984. . . . **Fred Elser** writes that he is moving to Georgia in May. His son's wife, Donna, has been in the hospital in Augusta for about a month and Fred feels his son can use his help.

Jonathan Arnold reports that he has several times attempted to correct the records on his father, **J. Howard Arnold**, who died of heart failure nine years ago at the age of 63. If your secretary ever received a notice earlier of Arnold's death and failed to publish it, Jonathan has my sincere apologies. . . . **Arsene Morin** died April 22, 1984. . . . **Frederick J. Turner** passed away on April 23, 1984. At the time, he was a partner in the consulting engineering firm of Reardon and Turner of Boston, which he helped found in 1952. He was a registered professional engineer and a member of the New England Society of Professional Engineers. Besides his wife, Mary A. (Brown), he leaves his son, Paul M., of Framingham, Mass.; two sisters, Alice and Mary Turner, both of Swampscott, and two grandchildren. . . . Mrs. E.B. Dane, '30, reported that she learned from the *Boston Globe* that Mrs. **Elise DuPont Elrick** died on March 24, 1984. No further information was received. . . . Information has also been received that Captain **George C. Humphreys** passed away on April 12, 1984. George was the assistant to the president of Benrus Watch Co. and vice-president of Stilson Associates of Fairfield, Conn. After graduation, he joined the navy and retired after 20 years in 1963 with the rank of captain. Survivors include his wife, Josephine; a son, W. Blake of Milford; two daughters, Mrs. Louise V. Neborak of Trumbull and Mrs. Susan Klein of Washington, D.C.; two brothers, James of Litchfield Park, Ariz. and Henry of Florida; a sister, Mrs. Marie Arnold of Maine; and four grandchildren. . . . Regretfully, we also report the death of **Daniel P. Johnson** on March 21, 1984. To the families of these classmates we extend our sincere condolences.

These notes wouldn't be complete without mentioning that your assistant secretary **John Swanton** and his wife, Louise, were given a surprise party for their 50th wedding anniversary. Their daughters arranged everything and, according to all reports, the party was a great success. . . . Sorry there was no class column in the August/September issue. Helen and I were in Greece when the notice arrived, and we returned home too late to send it in. Meanwhile, I thought it had been taken care of.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360

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Technology Day, June 8, was a beautiful warm day. Our class was represented by the following: **Wendall Blarce, John Brown, Melvin Castleman, Frances Gowen, Harry Johnson, Tom Weston, Richard Lobran, Douglas Miller** and **Charles Taylor**. The speakers were interesting and the luncheon reports indicated that M.I.T. was in a healthy state. There was an impressive memorial service for alumni reported deceased from April 30, 1983 through April 27, 1984. Our class contained the following: **Robert W. Baschnagel, Alfred B. Berghell, Alexander C. Burr, Kenneth A. Cameron, Francis S. Chambers, Jr., Louis L. Colin, Charles L. Davis, Jr., Walter J. Duffy, Edwyn A. Eddy, Camilo Gutierrez, James E. Harper, Everett W. Harris, Charles W. Isselhardt, Robert W. Lawson, John W. Leslie, Stephen Lichtblau, Webster E. Morse, Dominic A. Perry, Howard R. Pyle, Albert S. Rice, Joseph L. Richmond, Henry T. Smith, Leroy Smith, Jr.**, and **Myron L. Williams**.

I had the pleasure of meeting **Morris Etstein** at a social gathering. He told me that after a varied and interesting career, which included working at Independent Lock Co., service in the U.S. Ordnance Department, jewelry chain business and coated fabrics, he retired in 1975. At present he is active in SCORE. His hobbies are waterpainting and golf. Yes, M.I.T. was important in his life. His father-in-law graduated from M.I.T. in 1911 and his daughter received her Ph.D. at M.I.T. He and his wife keep in close touch with their two daughters and two grandchildren.

Charles Taylor reports that our classmate **Joe Santoro** died on June 11 from a blood condition that developed a few years ago. Charles used to see him from time to time around Boston when Joe was working at the army base and later at the navy yard. Charles himself has much arthritic pain, with which he has learned to live. His new medicines seem to be working better, and he recently has been more active. He also saw **Timothy P. Coffey** and said he is "looking good."

Maxine and **Wendal Bearce** manage to do a lot of traveling. This year Greece and Israel are on their list. . . . **James Alan MacDonnell** died on April 19, 1984. He was executive vice-president of Gilbert and Barker Manufacturing Co. in West Springfield, Mass., where he worked for 33 years. Later, he worked for Dresser Industries in Houston, Tex. Mr. MacDonnell was a communicant of St. Theresa Church and a member of the Abenaqui Country Club and the Portsmouth Rotary Club. He is survived by his wife Bernice and son Robert. . . . We also have received the sad news that **Henry Arthur Phillips** died on August 2, 1980.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Here it is almost fall again and our Florida folks will be headed south shortly. We have quite a number of classmates down that way and when your new *Alumni Register* comes, you can find who lives nearby-Florida or near your own hometown.

A letter from president **Dick Morse** gives us the roster of class officers elected at the last reunion. Besides Morse, we have **Dick Fossett**, our original president serving as vice-president. **George Stoll** continues as treasurer; **Herb Grier** is our class agent; **Cy Hapgood** can answer our questions about estate gifts; and I'm at the bottom of each of these class notes.

Dick Morse tells us that at 65 he stopped lecturing on new enterprises at the Sloan School, and at 70 he retired as a director and consultant for Dresser Industries. He continues as director of three new high-tech companies. He will be spending three months in Massachusetts, three months in Florida, and three months at the Cape. Last January he did make that trip to the Antarctic and reports it is the most beautiful place they have ever seen. The **Cy Hapgoods** and the **Niazi Mostafas** see the Morses occasionally.

President Paul E. Gray, '54, welcomes Enar Eskilsson, '34. Eskilsson, who works with the Swedish International Development Authority to help develop power systems for third world countries, returned to the Institute for his 50th reunion, his first visit since graduation. **Photo: Frank Revi, '86)**

We are all sorry to learn that **Dayton Clewell** lost his wife, Jean, last winter. She attended a number of reunions with Dayt and we remember her most pleasantly. . . . **H. Irving Crane**, who received a Ph.D. from Tech after finishing with our class, died in Vermont last spring. He worked with Honeywell until his retirement in 1976. . . . **Cornelius Griffin**, financial analyst, who was living in California after 35 years in the Boston area, has also died. . . . **Benjamin Smilg** lived in Dayton, Ohio, until his death last November. He was connected with the aeronautics industry in some capacity during most, if not all, his business career. . . . **Herb Grundman** graduated in civil engineering but soon went to the airplane field. He died in Florida last spring.

Walt Duncan is growing up like the rest of us: he and Janet attended the graduation of a grandson at Yale in the rain, and he says he's not going to another unless sunshine is guaranteed. . . . Frances (Mrs. **Warren Henderson**) writes a nice note saying she can hardly wait to meet the Class of 1933. . . . **Clarence Westaway** will send news about Technology Day. . . . How about some of you dropping me a note about your activities!—**Beaumert Whitton**, Secretary, Cottage 112, Sharon Towers, 5150 Sharon Rd., Charlotte, NC 28210

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Our 50th Reunion has come and gone, and what a success it was! About 160 class members attended, and wives and several widows of classmates brought the total to approximately 240. The weather cooperated by giving us clear days and no rain; the record-breaking hot spell was better than the three-day northeaster we had 25 years ago. We must acknowledge our appreciation to Joe Martori and his staff from the Alumni Office. They handled all the logistical arrangements and

were always on hand to pick up any loose ends.

The Reunion began Wednesday evening, as **Paul Wing** showed us a number of his stereoscopic pictures. He holds a pre-eminent position in this specialized area of photography. . . . A proud moment came at the Technology Day luncheon when the class gifts were presented and **Hank Backenstoss**, our Class Gift chairman, announced the presentation of $2,300,000—the total amount that had accrued in the past five years. This gift represented a participation of over 77% of our class members. . . . An interesting additional gift was a small tapestry showing a portion of the Great Wall of China, sent by classmate **Wing Lem Wu**, who teaches at the Beijing Institute of Aeronautics. Unfortunately, because of Chinese currency restrictions, that was as close as he could come to being with us. . . . Most of the old faithful attendees from past reunions were present, but there is something about a 50th that brings new faces—maybe just to prove you still can make it. It was fun for me to meet, for the first time as far as I can remember, people about whom I have written, like **Jerry Raphael** from California and Father **Joe Hahn** of the Maryknoll order. . . . We had some long distance travellers: From Uppsala, Sweden, came **Enar Eskillson**, who received an E.E. master's degree with us. He is with the Swedish Electricity agency and was able to include the reunion as part of a trip to the West Coast to see what's being done in that area to supply power to communities that are so remote from power grids that transmission lines are not economically feasible. . . . Another long-distance traveller was **Bob "Radio" Hisamoto**, who lives in Alaska. He brought his wife and some of his children along.

The reunion officially wound up Sunday after brunch with a class meeting that re-elected the same officers for the next five years, reappointed **Carl Wilson** as Reunion chairman and **Hank Backenstoss** as Reunion Gift chairman, and agreed that a specific effort should be made to plan for an interim mini-Reunion in the next two or three years. After the formal affair broke up, about 60 of us headed for the Cape Codder Hotel, right on Buzzard's Bay, near Falmouth. We diehards left there Wednesday after a full week of fun, good company, and the pleasure of renewing old acquaintances.

For those who didn't come, there are still some copies of the book of biographical data on more than 200 members of the class; if you would like one, send a check for $13.50 to **Laurence Stin, Jr.**, 374 East St., Hingham, MA 02043. This will bring it to you post-paid.

Inevitably, it seems, there are more losses to report. This month I have three, with nothing but names and dates. **Wallace Cogdill** died in Naples, Fla., in August 1983; **Robert Faunce** in Richmond, Va., this past March; and in the same month, **Brennan Sellers**, in Greensburg, Pa. Mr. Sellers made M.I.T. a beneficiary in a portion of his residuary estate and the Institute received an initial payment of $37,500 that presumably came in time to be included in our Reunion Gift total. I hope that word will get back to the families of these classmates of our sympathy on their losses.

Happily, we can wind up with some pleasant items, as several Alumni Fund notes are at hand. **Eugene Magenau** writes, "Busier than ever in retirement, with occasional consulting jobs, do-it-yourself projects, playing tennis, and reading *Technology Review*. In January, drove 5,500 miles to California via Florida, with a notable stop to visit F. L. Wright's Taliesin West in Arizona." . . . From Oklahoma City, **Willard Chandler** writes, "Retired from Capitol Paint Manufacturing Corp. as technical director on January 1, 1984. most of career spent in paint industry, initially with Du Pont (Everett, Mass.; Chicago, Ill.; Mexico City), then Fuller Caribbean (San Juan, P.R.) . . . **Walter Nisula** says "For three years, I have been trying to schedule a trip overseas to Finland and cousins. One reason was the completion of a book on the history of Finns in New England, 'The Finnish Imprint,' to which my wife and I contributed

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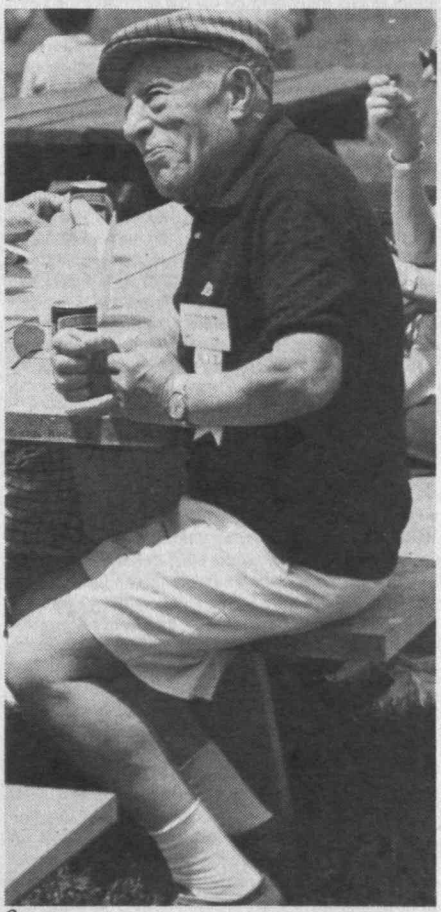

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Celebrating their 50th reunion, 240 members, wives, and guests of Class of 1934 returned to the Institute in June. Their reunion program included a variety of activities. 1. Kae and Frederick Johnson at Priscilla and President Paul Gray's reception June 7. 2. Jack Pekin (left) talks with Al Hurst in the president's garden. 3. With McCormick Hall as their home base, Class of 1934 traveled by bus to off-campus activities. 4. Dr. and Mrs. Nathan Goodman at the Museum of Fine Arts. 5. Fred Parks takes a closer look. 6. Pre-Pops buffet at Walker Memorial. 7. Dorothy and Gordon Burns (left) and Natalie and Sam Brown at Thompson's Island. 8. Isaac Perlmutter partakes of 1934's New England clambake, complete with lobsters. (Photos: Frank Revi, '86)

text and pictures. I donated a copy to the M.I.T. library." . . . **Wilbur Paulsen** writes, "Spent an interesting three weeks with classmates **Bob Franklin** and **John Holden** in March and have some fascinating pictures. Plan to spend two weeks at Boothbay Harbor this summer—sailing and playing tennis."—**Robert M. Franklin**, Secretary, P.O. Box 1147, Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

35

We had a good turn-out Technology Day, June 8, with the following on hand: **Leo Beckwith**, **Art Cohen**, **Ned Collins**, Sarah and **Phoenix Dangel**, Janice and **Leo Dee**, Jane and **Pete Grant**, **Rush Lincoln**, **Allan Mowatt**, Rhoda and **Bernie Nelson**, **John Taplin**, and our new honorary class member **Warren Seamans**. The nominating committee asks you to write any of us with your suggestions for officers. We are: **Leo Beckwith**, chairman, Galloupe's Point, Swampscott, MA 01907; **Hal L. Bemis**, P.O. Box 243, Haverford, PA 19041; and your secretary.

I always receive lots of notes and letters in the process of organizing the class golf tournament—this year is the 24th! **Frank Hatch**, Burlingame, Calif. writes, "I've been busy with various types of non-paying activities: secretary of the Rotary Club of San Mateo, history and heritage chairman of our ASME Section (I'm in the ASME Old Guard now!), house and arrangements of the Golden Gate Port of the Propeller Club, making furniture, and playing golf. My wife is doing very well after heart surgery. Our younger daughter and grandson are at Charleston Air Force Base, S.C., where her husband is a colonel-select and acting deputy of operations in the Air Transport wing. As for the reunion next year, I would certainly like to come, but we'll have to wait and see how Marjorie feels."

Dick Shaw writes from West Hartford: "I must withdraw from this year's tourney, not for lack of interest, but because there is too much to do between the return from a delightful trip around the British Isles on the *MTV Argonaut* and departure to Groton Long Point on June 30! But please let me have the results as they come in." . . . **Hank Ogorzaly** writes from Summit, N.J.: "I am sorry to see that we will not be able to have a re-match this year, except in the unlikely possibility that we each win our first three matches. . . . I will be leaving for California where Jewel and I intend to spend the rest of June with kith and kin. Golf is not on the program. I shall try to get a game in on our return but may miss your July date by a day or two." . . . **Al Johnson** writes from Reading, Mass., "We are leaving for London this evening and will be gone for two weeks. Whether I can get in 18 holes in time when I return, I don't know." . . . **Ken Finlayson** writes from Rye, N.Y., "Wonders never cease! It all fell together (he had a 91) now to break 90! After August 1, I hope to play more often." Ken retires officially on August 1 from the Heywandt-Robinson Co. where he has been for a number of years.

Dick Bailey writes from Kingsport, Tenn., "I will not be going up to New England this summer as far as I know. I made a quick trip in April to see my mother on her 91st birthday and stayed in Scituate. She is doing fine, playing cards and gadding about with a walker. I'll be missing some golf dates because Barb and I are going to Europe June 9 to July 11. We're picking up a Volvo in Gothenberg and driving in Europe and the British Isles. I still have some friends in Belgium, France, and England. I hope to make a tennis playing trip, playing at different clubs. I used to belong to one in Salisbury, England, which has invited us back. I'd like to play some golf but it will be difficult because Barb doesn't play—bad back. We are real excited about it all. I ought to have something to talk about at our 50th."

I have received two cards from **Les Brooks** while on his extended trip, one from the Mojave Desert area and the second from Yellowstone Park. . . . **Leo Beckwith** says daughter Carol just arrived from Niger, Africa with hepatitis, so he'll be busy helping her recuperate in July. . . . **Hal Bemis** says he will try the gold again but his orthopedic surgeon wants to give him a new knee. "In the meantime the few times I've played do not resemble golf!" . . . A letter from **Barney Freiberg** was a nice surprise: "There's a good chance that Zee and I will attend the 50th reunion, so I am answering your appeal for oarsmen. However, 10-20 strokes is hardly worth suiting up for. I'm sure we have enough members in good enough shape to go one-half mile or so. Every once in a while I come across an M.I.T. alumnus of about our vintage who can play tennis for a couple of hours a day. I have a picture on the wall of my den of a crew that includes **Art Haskins** and me; and I remember rowing with **Bob Olsen**, probably as a freshman. It would be fun to row again after a 50-year layoff." That's great Barney, I didn't want to scare anyone off thinking we would do any racing!

Bud Pflanz sent me a note after receiving a phone call from Ellie that **Paul Germond** had died after a long illness on June 15 in Englewood, N.J. I have sent a card to her expressing the sympathy of all his classmates. . . . I also received belated information on the death of **Arthur J. Lariviere** in Worcester on May 7. Arthur was a past president of the M.I.T. Alumni Association. I have sent expressions of sympathy to his widow, Mary, from us.

I talked to members of the class of 1934 who boated a crew for their 50th on the Thursday before Technology Day, which made the rowing a much more relaxing and enjoyable event. I would like to receive thoughts from our oarsmen about coming in a day early and rowing Thursday morning instead of the usual, heavily scheduled Friday morning. And we'll go for the "one-half mile or so!" **Art King** who was our crew manager in 1935 has agreed to be on hand to help us get the shell out onto the water and pushed off from the float. **Phil Johnston** should be around for that too!—**Allan Q. Mowatt**, Secretary, 39 Congress St., Apt. 5, Nashua, NH 03062

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Alumni Day produced a table full at the luncheon including Kitty and **Herb Borden**, Rose and **Ed Dashevsky**, **Vince Estabrook**, Vivienne and **Eli Grossman**, **Leo Kramer**, Florence Cooperstein, and your secretary. Leo reports that he has sold his Belmont home, established a pied-a-tierre in Chestnut Hill, and become a resident of Florida where he can be found playing golf in Palm Beach Gardens. The rest of us are going on as usual.

The mailbag this month is full of sad news: **Norman Copeland** died of a heart attack at his home in Tequesta, Fla. on April 30. Prior to his retirement in December 1977, he was a senior vice-president and member of the executive committee of Dupont. He started with the company in 1937 in the engineering department and transferred subsequently to the film department. In 1954 he became plant manager of the Old Hickory, Tenn., cellophane plant. Over the years he acquired an M.S. and a Ph.D. in chemical engineering from the University of Delaware. A registered professional engineer in Delaware, he had received the Society of Manufacturing Engineers' Interprofessional Cooperation Award in 1974 and was named Delaware's outstanding engineer for 1976. He was a widower and is survived by two sons, Eric of Wilmington and Terry of Florence, S.C., two grandsons, and a brother.

Clarence Horton died June 5 on Cape Cod. For 25 years he was the chief marine engineer for Dravo Corp. of Pittsburgh. He was responsible for the development of the Kort nozzle, which greatly increased the maneuverability of tugboats and towboats. He also introduced push towing on the Rhine River, which revolutionized the towing business. For several years he was an independent consulting naval architect in Wilton, Conn. His move to the Cape was fairly recent. He is survived by his wife, Louise, two daughters, and two grandsons. . . . Belatedly word has come of the death of **Leonard Lang** some years ago. His home was in Pittsburgh and he was associated with the Kas Center at the University of Pittsburgh. Any further information would be appreciated.

Now, on a more cheerful note, if any of you can find your way to West Hartland on Saturday, October 27, do let me know. If you give me enough time, I can send you a map!—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

37

In December 1982 **John K. Jacobs** of San Francisco, Calif. sent his friends greetings and good wishes in the form of an essay, "Hanging Out." John's essay, in part: "Now that I am going to retire, the questions come up 'Where to?' and 'What next?' When people ask me what I am going to do, now that I will no longer be contributing to the gross national garbage, I answer that I am going to 'hang out.' There is a proposition that says, 'You can't win, you can't even break even, you can't even quit the game.' Hanging out is an approach to quitting the game. It is an art form that attempts to deal with reality and time. Reality is not self-evident. (A fish would be the last to discover water.) We perceive what we have been conditioned to recognize and what is 'useful.' We are caught up in the symbols of language and the labels that stand for realities. Hanging out implies that there are no uninteresting things, just uninterested people—that everything has its beauty if we only learn how to look for it. Hanging out means that you must be empty so that you may become totally receptive to whatever the environment has to offer. You feel that everything must be as simple as possible (but no simpler!), and you feel that all facts are negotiable.

"It all started a year ago when I began my escape from the tyranny of time by discarding my watch. I decided that time does not really exist—it is an invention man uses to mark his brief stay on this lovely planet by measuring the infinite with a finite tool. The watch provides the illusion that we are controlling events. In our foolish attempt to escape the mad rush toward oblivion, we have not had time to look around.

"Hanging out is more than just sitting around although sitting can be great. Like sitting by a campfire with Elizabeth, or sitting on the grass in Washington Park while the kids play, or drinking beer and listening to Caruso records at LaTosca in North Beach, or listening to chamber music in the olive grove at The Cannery. But hanging out, as an intense awareness, need not be passive. It can be making ten non-stops on KT West Face. It can be playing racketball really well and lying in the steam bath afterward. It can by bicycling in Golden Gate Park with Elizabeth or running the Marina Par-Course with Karen. It can be playing chess at the Mechanics Institute or at the Vesuvio or at a coffee house in North Beach. It can be climbing down the rocks on the headland beyond the Gate and running nude on the beaches below. It can be a wild ride on my Windsurfer when the wind and waves are just right. It can be improvising on my piano or writing a little poem. It can be running up the Throckmorton trail on Mt. Tam. It can be turning a bowl of good hardwood on the lathe. It can be just watching from my window as the sun sets over Mt. Tam while the fog rolls up the bay. When we hang out, if we listen attentively, we may hear (among the roar of nations) the faint flutterings of wings, the gentle stirrings of life and hope."

Ross E. Black of Waterford, Conn. is retired from the L.I. Lighting Co. He is still doing some quality assurance consulting. He is active in the

American Society for Quality Control and historical projects including an archeological dig in his backyard. . . . It is with deep regret that I announce the following three deaths: **Mortimer H. Nickerson** died in Leesburg, Fla., on April 28, 1984. He is survived by his wife Lucille, 112 Wilson Lane, Leesburg, FL 32748; a daughter, Gail Smith of Maryland; and a son Craig, of Quincy, Mass. . . . **Robert A. Stanley** died March 28, 1984 at Martin Memorial Hospital, Stuart, Fla. He is survived by his wife Muriel of 3792 N.E. Ocean Blvd., Apt. 101, Jensen Beach, FL 33457 and his three sons: Robert of Panama City, Fla., Richard of Milford, N.H., and Gordon of Newport, N.H.; and a daughter Jean Lesser of New York City. . . . **Howard B. Bishop Jr.** died April 3, 1984 and is survived by a son David.—**Lester M. Klashman**, Assistant Secretary, 389 Elm St., Apt. 71, Medford, MA 02155; **Robert H. Thorson**, Secretary, 506 Riverside ave., Medford, MA 02155

38

A final wrap-up on the mini-reunion last June at Endicott House: attending were **Paul Black**, **Mead Bradner**, **Ross Cooper**, **Paul Desjardins**, **Ed Hadley**, **Horace Homer**, **Hoppy Hopgood**, **Bob Johnson**, **Sol Kaufman**, **Frank Kemp**, **Norm Leventhal**, **Dale Morgan** (who,incidentally, is as far as I know the first great-grandfather in the class), **Dave Morse**, **Paul O'Connell**, Prexy **Don Severance**, **Ed True**, **Dave Wadleigh**, and our honorary classmate **Hugh Darden**. Among the missing were **Ira Lohmann**, who was in Europe all of June; **Haskell Gordon**, also in Europe, sailing down the Rhine; and **Fred Kolb**, whose son was getting married in Dallas at that time. Fred is still with EK, working 40 hours a week in the Magnetic Media Lab. If you haven't been to a mini-reunion, **Don Severance** is planning another one for next June—"try it, you'll like it."

Art Gould, who has been a member of the Lehigh University faculty since 1947 retired this year as professor emeritus of industrial engineering. . . . **Miles Leverett**, Sc.D. '38, was recently elected to the National Academy of Engineering. . . . I recently learned that **Fred Schmitt** passed away last March. Fred is survived by his wife Kathryn, Presently living in Mountainside, N.J.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

39

One hundred forty (74 classmates with wives and guests) celebrated our 45th reunion at Martha's Vineyard in June. Five other classmates joined the Technology Day activities on campus. This large attendance set a new Institute record for a 45th reunion. (If you would like a list of attendees, write Sandra Knight in care of the *Review* office.) Co-eds, too, set their attendance record when 33 percent attended, including **Ruth Berman Pitt** and **Ida Rovno Gordon**, formerly known as "ace reporter" on *The Tech* newspaper.

Aaron White's superb choice of the Russ Kelsey Band earned compliments from all listeners and dancers. A free-running and high-flying jazz piano solo by Louise (Mrs. **Vahey Kupelian**) backed up by the full band, added just the right touch. . . . Jean and **Joe Dana** arranged the sports. Jean demonstrated her power-driven cross-court forehand. However, a shortage of golf clubs prevented **Mike Herasimchuk** from demonstrating play to his six handicap. . . . Prilla and **Gus Hunicke** entertained more than 50 during several trips aboard their spacious sailer. The cruises brought joy to all, especially those surviving an extra thrill caused by a well-meaning apprentice tillerman, a former resident of Puerto Rico, who tried to submerge the leeside gunwale. . . . There was a show of classmates' slides taken at prior reunions when girths and wrinkles were in preliminary stages of development. Enthusiastic and eagle-eyed viewers called attention to various high points, including a tiny run in the silk stocking on one shapely leg.

Dotie and **Bob Casselman** were especially honored with a certificate of recognition for outstanding career achievements and high esteem. Bob's response was not taken from the book he authored, but it probably was the briefest of any such responses ever made. . . . **Charles Parker** made patriotic comments on D-Day anniversary and led singing of "America The Beautiful," rendered from the heart by all of us whose lives, just after graduation, were deeply affected by World War II.

Fred Schaller, reunion treasurer, reported balanced finances for the reunion. He said there were no requests for rebates due to unused bar tickets. . . . At what may have been the shortest non-recorded class meeting ever, and with the absolute absence of any railroad-like noises, the following class officers for the next five years were elected: president, **Seymour Sheinkopf**; vice-presidents, **Aaron White** and **Oz Stewart**; treasurer, **Joe Dana**; class agent, **Fred Schaller**; estate planning, **Manning Morrill**; secretary, **Hal Seykota**. **Ernie Kaswell**, retiring president, received a handsome gavel as token of appreciation from our class.

Now we have fond memories of fun shared at this 45th reunion. Let's think ahead to our 50th and know our new president will need a great chairman to organize and run it. Volunteers may please advise Seymour of their desire to help.

Leo Weiss has generated an unusual career and has earned extraordinary recognitions. His hobby was engine-driven radio-operated model airplanes, and in 1936 Leo won the national power models contest. This plane is now on display in the Guggenheimer Aeronautical Laboratory. Leo went on to display other talents. He was invited to become a member of the prestigious Young Presidents Club and became founder of a business based on manufacturing and selling a product he invented (a capacitance gauge to register fuel weight, instead of fuel volume, in airplanes). *Fortune* Magazine reported in 1954 that Leo's company grossed $7,400,000 and netted $400,000 after taxes. Leo has been active in the M.I.T. Clubs of Long Island and Washington, D.C. and now contributes much time to the M.I.T. Enterprise Forum of Washington, Inc., an organization dedicated to listening to, advising, and helping qualified individuals become successful entrepreneurs. Leo, your classmates join in presenting their compliments. Aletta and **Bob Touzalin** wrote from England's Lake District that they enjoyed spectacular sights and bargains recently in Yugoslavia, and expected to return soon to their Florida home and golfing and pewter hobbies. . . . **Harold Chestnut**, in retirement, is giving time and his considerable talents in altruistic endeavors to develop supplemental ways for improving international stability. . . . **Larry Lyons** writes from Santa Fe, N.M.: "It is with sadness that I advise you of the death of **Phillip W. Constance** on March 31."

We were saddened by report of the death of **Alder Bowser** during March at Los Altos, Calif. Alden's career included working with ITT and the Civil Aeronautics Administration installing equipment for blind landings at airports on several continents. . . . **Ralph Woollett** was flying alone in his single-engine plane during early April when it crashed and he was killed. Ralph was an internationally-recognized authority on transducer theory and design, and he had been working on development of submarine electronics and weapons systems for the Naval Underwater Systems Center at New London.

After the reunion Hilda and I completed our 8,672-mile journey in the car Anne and **Ben Howes** helped us buy seven years ago. Our route was from La Jolla via Florida and Martha's Vineyard to Tacoma, where we now seek new residence. The **Jim Bartons**, **John Alexanders**, **Hans Bebies**, **Holden Withingtons** join us in inviting classmates to enjoy our welcome here in the Pacific Northwest.—**Hal Seykota**, Secretary, 2853 Claremont Dr., Tacoma, WA 98407

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In less than ten months our 45th reunion will be here. . . . let's make it a great one! **Norman Klivans**, our class president, arranged a breakfast meeting at the Hyatt on June 8 with **Jim Baird**, **Ed Bernard**, **Chuck DeMailly**, **Dick Gladstone** and your secretary attending. Jim was elected chairman of the 45th reunion program. Plans call for spending Wednesday and Thursday nights, June 5-6, in Cambridge (either at the Hyatt on Memorial Dr. or the graduate dorms), with the usual two-day program. Because some alumni would like to spend another day in the Boston area (things have really changed in the city), an additional 50 rooms were reserved at the Hyatt for Tuesday night, June 4. First come, first served.

Early on Friday afternoon the group will go to Woodstock Inn in Vermont to spend the weekend. A schedule of activities will be forthcoming. Jim welcomes any and all offers of assistance and/or any ideas or comments that would make the 45th the very best! He can be reached at 92 Webster Park, West Newton, MA 02165, (617) 332-7199.

Ed Bernard, our class treasurer, was elected comptroller of Careers for Later Years, Inc. by its board of directors. This non-profit organization is involved in assisting employers secure qualified people who are in retirement but would like to resume work. Ed was also elected co-chairman of the M.I.T. Boston Seminar Series for 1984-85. . . . A news clipping indicates that **John Danforth**, who has been a trustee of the Westwood, Mass. library since 1981, has investigated, recommended and submitted a warrant article to provide start-up costs for an automated circulation system. This new equipment uses a laser beam to scan a bar code on the book and on your library card, recording the loan and the return. . . . **W.H. Krome George**, the former chairman of the board and chief executive officer of ALCOA, was elected to the national council of the Salk Institute for Biological Studies in La Jolla, Calif. this past April. This council is composed of distinguished national and local leaders whose interests are to advance the goals and objectives of the institute and to help create a positive image around the nation. He continues as an ALCOA director and chairman of the executive committee of the board.

Sam Goldblith, M.I.T. vice-president for Resource Development and professor in the Department of Nutrition and Food Science, was decorated by Japan on June 1 for his efforts over many years to promote friendly relations and mutual understanding between the U.S. and Japan. Sam, who survived the Bataan March in 1942 as a young army lieutenant, did not allow bitterness and hatred to prevail. He says, "It's not a matter of forgiveness. It's whether you look to the past or the future. If the past, it's hatred which brings on war. If the future, it's love and that brings on peace." Sam has had extensive contact with Japanese industry, and under his direction some 50 companies have become supporting members of the M.I.T. Industrial Liaison Program.

News items from the Alumni Association office indicate that **George A. d'Hemecourt, Jr.**, is still active as president of d'Hemecourt Properties, Inc. . . . **Louis Michelson** recently retired as president and CEO of Lion Precision Corp. in Newton, Mass. . . . Sad news to report on the death of **Charles H. Strang** on May 13, 1984 at the Milton Hospital in Milton, Mass., after a long illness. Charles had worked for General Electric in Schenectady for 38 years before retiring as manager of quality assurance and moving to Milton approximately eight years ago. He is survived by his wife, Bianca, a son, and a daughter. . . . **Wesley J. Van Sciver**, professor of physics and a Lehigh faculty member since 1962, was honored at the University's annual faculty-staff dinner on May 9. He was scheduled to retire as professor emeritus on September 1. . . . All the news for now. Please keep it coming—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

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A newsy letter from **William R. Johnson**; he runs Newmet Products, Inc., a stainless steel powder metallurgy business in Terryville, Conn. The Johnson family is still involved with Tech: younger son graduated in 1984 and daughter is married to a Course I graduate; to complete the Boston connection, older son just married a woman from B.U. Bill's M.I.T. Outing Club training helped on his trek in Sikkim with Tenzing Norgay, the Sherpa who climbed Mt. Everest on the Hillary Expedition. Bill and Jean visited **Fred Fleischauer** and his wife, Jean, in Pittsburgh. Fred "looks great and is semi-retired, working out of his apartment on technical communications exchange."

Hope you did not miss the article on acid rain by **Alan Katzenstein** in the *Wall Street Journal* (June 28). The cartoon caption in Alan's article says it all: "The acid rain debate is between some who would act on preliminary data and others who say the costs of doing so may be too high."

Another wonderful letter from **Charlile Stempf**, our representative Down Under. Charlie writes, "The in thing here is to invest in movies or TV specials. I rejected a film called 'Phar Lap' that sounded like just another racetrack saga—'National Velvet' with kangaroos—but turned out to be the big money-maker of the year. The one I bet on, an atom-bomb-in-Sydney melodrama, has been universally acclaimed as the worst movie ever made. With a minimum bet of $5000, one does not reinvest in this lottery without further inside knowledge. So I've joined Actors Equity and am in great demand as an extra due to my bulk, my snowy white beard, and my baby blue eyes. There is a Disney opus playing in the States right now called 'Five Mile Creek,' in which I am to be seen throwing nuggets out of my mine shaft, carrying picks, shovels, bags of cement and other impedimenta, and fraternizing with whore ladies at the bar."

Colonel **Dick Gibson**'s retirement activities include judging for U.S.Y.R.U. and intercollegiate sailing races, serving as navigator on last year's Marion-to-Bermuda race, and acting as an emergency medical technician for the local Volunteer Ambulance Service. . . . **George Toumanoff** retires at the end of 1984 and will join the ranks of more-or-less full-time sailors. . . . After **Bob Imsande**'s retirement from Anheuser-Busch, he and Betty have moved from St. Louis to a house right on the golf course at Escondido, Calif. He is reducing his handicap by playing golf several times a week, when not instructing at Sailplane Enterprises in Hemet. Bob attended an M.I.T. San Diego Club meeting and met **Bill Hahn** there.

Lloyd St. Jean passed away in May. He was a senior engineer at Sanders Associates and a longtime member of the National Rifle Association. Our sympathy to children, Richard, Ed, Carol, and Pam, and to granddaughter, Kaitlin.—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

43

Jim Hoey, bless his heart, gets tired of reading my complaints about no news, so from time to time he bestirs himself and finds some, which he obligingly forwards.

First, about himself. He took off for Florida last January and visited **Bob Caldwell** in Boca Grande. Bob has a beautiful new home on a waterway leading directly to the Gulf of Mexico. He also has a fishing machine called *Runaway VI*, in which Jim enjoyed a fine day at sea and caught several fair-sized groupers. Bob's son Bill served as fishing guide. He is following in his father's footsteps by starting his own home construction business. Bob extends an invitation for all classmates to call him whenever they are in his area. . . . **Bill Lay** in Orlando helped Jim find a place to park his automobile while he went to Mexico for the M.I.T. Fiesta, where he was the only member of '43 attending. Jim reports that Bill seems to be surviving in the citrus industry despite all its current problems. . . . **Hans Walz** also had a Florida tour and visited with **Rupe Hughes** in Gulfport. Rupe has apparently made a remarkable recovery from his illness.

Simon Gluck is still with Burroughs Corp. in R&D. He has four sons, ages 19-26. . . . After many years with United Aircraft (United Technologies), **Jim Casserly** is now retired. He drives a school bus in Glastonbury, Conn., takes the liberal arts courses he missed at the Institute, and generally enjoys life. . . . **David Crawford** has retired after almost 30 years with IBM. . . . **Tom Dolan**, who spent more than 25 years in St. Louis, finally succumbed to homesickness and returned to the Boston area, where he is living in Canton. . . . Present at the Technology Day luncheon on June 8, along with Jim, were **Ken Warden**, **John Ward**, and **Russ Coulson**. Russ came all the way from Englewood, Colo. He is now president of Nelson, Coulson, and Associates, the firm of consulting engineers which he joined when it was J.R. Nelson and Associates.

A brief note comes from **Richard B. Morrison**, Course XVI. He is a consultant to Aerojet for its Japanese projects and its air-turbo-ramjet programs. Dick and his wife spend a lot of time sailing the Chesapeake in their 27-foot Tartan, *Choucoune*, but have enough time left to visit four married daughters and 11 grandchildren.

The centennial celebration of the M.I.T. Symphony Orchestra last May included an American premier of Three Movements for Orchestra by Robert Dix (Sc.D. '43) of New Canaan, Conn. In his business career Robert became president and chairman of Exxon's U.S. chemical company, and later senior vice-president of the parent company's international chemical operations. Music has always been a prominent part of Robert's life, but he did not become interested in composing until 1970, at which time he undertook studies at Juilliard. He took early retirement in 1977 to devote full time to music, and has written compositions for a variety of chamber ensembles, as well as for full orchestra.

Don't make Jim do all the work. You can send your news directly to me.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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There were more than 150 (some for the first time) of us—classmates, spouses, and guests—who attended one or more of our 40th reunion activities at Newport, Cambridge, or both. This was the largest attendance since our 25th, which was held on campus. Between courses at the class' Chinese wedding banquet, **Bob Breck** presented a slate of officers for the next five years: **Norman Sebell**, president; **Norman Beecher**, **James Hield**, **John Hull**, and **Will Rodemann**, vice-presidents; **Stanley Warshaw**, treasurer; **Andrew Corry**, **Louis Demarkles**, and **Melissa Teixeira**, secretaries; and **Edgar Eaton**, class agent. All were duly elected.

Last June more than 160 employees of M.I.T. who had retired between July 1, 1983 and June 30, 1984 were honored at a dinner at the Institute. Among them was Professor **Robert L. Halfman**, aeronautics and astronautics, 37 years. . . . Our belated condolences to the friends and family of **Edmund R. Jonash**, whose date of death is not known by the Alumni Association. . . . Happy Halloween from your secretaries.—**Melissa Teixeira**, 92 Webster Park, W. Newton, MA 02165; **Louis Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181; and **Andrew Corry**, Box 310, W. Hyannisport, MA 02672

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A June 24 note from **Jim Hoaglund** advises that Jim's old V-12 roomate, **James W. Speaker** of Menlo Park, Calif. died April 10 of cancer. In recent years Jim has worked for Hewlett Packard. He was a confirmed bachelor who finally married in 1971. Jim Hoaglund continues as chairman and CEO of McQuay, Inc.; more importantly, Jim reports that business is improving with a small first quarter profit. . . . Margaret (Mrs. **D.J. Lovell**) wrote in early May to advise that her husband had passed away on April 3. The Lovells have lived for many years in Stow, Mass. DJ's professional career centered upon optics in government and industry. Through the years DJ averaged about five technical papers per year. Margaret's note had a funny comment about bell bottoms which should bring back memories—fond and otherwise—to many. . . . **Charlie Patterson** of North Attleboro, Mass. retired from Texas Instruments in September 1983 after 37 years. Jan and Charlie are enjoying their newfound leisure both in the south and southwest as Charlie seeks newer and more challenging golf links. Charlie considers himself "between jobs" and not in retirement!

Fran and I continue to enjoy our periodic phone conversations with **Vince Butler**. . . . Fran and I are pleased to report that daughter Betsy (B.A., Smith, '78; M.B.A., Boston University, '84) married Larry Schembri, Ph.D. '84, on June 16. Larry will be an assistant professor of economics at Carleton in Ottawa while Betsy will be joining Clarkson Gordon in Ottawa as a staff accountant. Fran advises that Ottawa is only 7.385 hours by car from New Castle.

Prexy **Jerry Quinnan** has appointed **Tom McNamara** 40th reunion chairman, and Tom is off and running. We expect to see you all back home in Massachusetts next spring. Details to follow next month.—**C.H. Springer**, Secretary, Box 288, New Castle, NH 03854

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Bob Michaud, an old down-Mainer and VI'er whose last known address (LKA) is in Bedford, Mass., says he's director of hardware development for a company he helped found, Interactive Images, Inc. The name alone sets Bob apart. . . . On the facing page in the '46 *Technique* you'll notice **John Norton**, an old salt from Annapolis, via Franklin and Marshall, into Course XVI—poor devil—presently working for G.E. in Greenville S.C., managing gas turbine test operations. . . . Which segues to **Hal Oakes** on the same page, out of Ridgewood, N.J., through Course II, LKA Berkley Heights, N.J.

Ah! There're just too many to enumerate, but I'll try—V-12ers, if you'll excuse me, neat guys I like to think are alive and well: **Ford Park** a Course II'er out of Hamburg, N.Y., LKA White Plains, N.Y. . . . **Howie Perlmutter**, another II'er out of Framingham, now Professor at the University of Pennsylvania Wharton School of Business in Philly. . . . **Ed Potter**, good ol' XVI buddy out of Woodbridge, N.J., LKA Westport, Conn. . . . **Bill Rapoport**, chemical engineer out of Larchmont, LKA Morganville, N.J. . . . **Rich Rauch**, neat II acquaintance out of Lakewood, Oh., LKA Basking Ridge, N.J. . . . **Gene Ryan**, one of my/our XVI friends out of Schenectady, LKA Wynnewood, Pa. . . . If any of you amigos I've listed aren't paralyzed from the elbow down, drop me a line and let me know who else from '46 you might still be in touch with. . . . And that's about it, like it or . . . —**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222

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A class mini-Reunion gathered after Alumni Day in June, in the Bush Room on the first floor of Building 10, under the great dome. The special incentive—a gift copy of the Kepes painting "Open Horizons-M.I.T. '48"—was received by Gretchen and **Ray Ellis** of Marlboro, Mass. The incentive was to encourage a classmate to make

his first appearance at a Reunion. Hosted by our class president, **George Clifford**, and his lovely wife, Ginny, the mini-Reunion toured the adjacent Compton Gallery to see an exciting new exhibit on the American banjo. Just the tour was "worth the price of admission" to quote **Bob Sandman**, who arranged the event and hired his son's firm to cater the food and beverages. **Milton Slade** our class treasurer, said a good time was had by all. Also attending were Barbara and **Malcolm Reed**, Nancy and **Don Noble**, Anita and **Verity Smith**, Nancy and **Jim Manson**, **Dave Finnegan**, and **Stan Shein**. Claude Brenner, president of the class of '47, called George Clifford to determine our interest in a post-Alumni Day, off-campus event in 1985. One possibility Claude suggested was a weekend gathering in Newport, R.I. for the classes of '47, '48, and '49. George is considering the proposal on behalf of our class. As our president, George has met with the M.I.T. Alumni Fund concerning the plans for our class's 40th Reunion Gift in 1988. Our class has supported M.I.T. with generous contributions in the past, and George hopes to coalesce this support into a campaign that will generate a major gift from our class in 1988. The largest previous 40th Reunion Gift from living alumni is $2.3 million from the class of '43. Achieving higher goals is not an easy process, but I believe the class of '48 has the ability to provide a major gift.

G. Rohleder

Gil Rohleder has been elected executive vice-president and chief operating officer of Mapco, Inc., in Tulsa, Okla. Gil was one of Mapco's first employees, joining the company in 1960 as general superintendent. He was named vice-president in 1964, senior vice-president in 1978 and executive vice-president in 1983. Before joining Mapco, Gil held positions with Service Pipeline Co. and Warren Petroleum Co. Gil will be responsible for the day-to-day operations of Mapco and its subsidiaries. Mapco is an integrated energy company exploring for oil, gas and coal; producing and marketing oil, gas, coal, and precious metals; operating the nation's largest gas liquids and ammonia pipeline system; and producing and marketing liquid plant foods. . . . **Leon LaFreniere** has retired from his position as chief of the Laboratory for the Food and Drug Division of the State of Massachusetts. Leon is active in the Boy Scouts of America. About six years ago, he received Scouting's highest award, the Silver Beaver. This summer Leon is a counselor at a Scout camp on Parker Mountain in Barnstead, N.H. He also has tried his hand at being a travel agent. His wife, Rose, left her position at M.I.T. and has joined a firm in the swimming pool business. They have one grandchild. Their son is driving cross-country from Tempe, Ariz., to visit them this summer. . . . **Pete Richardson** retired as M.I..T.'s director of admissions after 12 years as director and 20 years in the admissions office. Pete was quoted in *The Tech* as saying, "I've loved every minute of it. I want to do something different, and I'll have time to think about what I'll do next." Pete and his wife plan to move to Woodstock, Vt., where they have owned a house for the past 15 years. Pete would rather not call his departure a retirement, "Retirement is not a comfortable term for a man who feels as vigorous as I do." Before returning to M.I.T. as associate director of the Admissions Office, Pete held positions at Webb School in California, Putney School in Vermont, Pomfret School in Connecticut and Athens College in Greece.

Our assistant secretary, **Sonny Monosson**, sends a news item about **Bernie Gordon**. At the spring I.E.E.E. Show in Boston, there was a session on "Engineering—Motivation and the Lack of It." One of the key speakers was Bernie. Sonny says, "He gave one of the most invigorating lectures about what engineering really is that I have heard in years—perhaps since I left the Institute." Bernie discussed the problem of current graduates from technical schools receiving a lot of segmented information, but because they have no knowledge of the overall problems they are helpless in solving them. Paying high wages to ineffective engineers and putting them in charge of projects that they can't finish has built up a large inefficient engineering structure in this country. By Bernie's measurements this structure is one-sixth less productive than it was in the early 1950s! . . . **Paul Anderson** was named vice-president and trust officer of Naumkeag Trust Co., a subsidiary of Eastern Savings Bank in Lynn, Mass. Paul has extensive experience as a trust officer in banking. . . . **Joseph Mallen** is president of Boeing Vertol Co. In May, he was guest of honor and keynote speaker at the annual meeting of the M.I.T. Club of Delaware Valley.

June Lanciani notifies us of the death of her husband and our classmate, **Dan Lanciani**. During World War II, Dan served in the Navy aboard the carrier *Lexington* and saw duty in the Pacific. From 1951 to 1959, he was one of the original engineers of Microwave Associates. In 1962, he founded Tritek, Inc., in Burlington, Mass., and operated an engineering sales representative business. June writes that Dan had a heart attack at their home in Gloucester. He died the same day at a nearby hospital. On behalf of our class, we send our sympathy to June and her son, Dan, Jr. . . . **Arthur Muldoon** died in January after a short illness. Arthur was president of Casco Chemical in Beverly, Mass. A longtime Beverly resident, he went to school there and lived there with his wife, Nancy. Our sympathy to his wife, mother, children and other family members.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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The 35th was a good reunion! We had Thursday night and Friday in Cambridge, and then a goodly group continued the festivities in Bermuda. You know, I have never stayed long enough in Bermuda to be ready to come home. Back to Cambridge: Ginny and I had no sooner walked into McCormick Hall than reunion chairman **Mickey Ligor** and Pam cooled us off with a cool one. **Harry Lambe** and Jean welcomed us, and presented us with our Beaver caps and our M.I.T. '49 sweaters—the caps we wore but the hot weather in Boston and Bermuda kept the sweaters in the suitcase. Dormitory rooms are much nicer in 1984 than they were in 1948, but there still aren't enough stalls or showers during rush hours. So, I had long talks with several classmates: **Herb Federhen** is with the Institute of Defense Analysis in D.C. . . . **Warren Fisher** and Daphne came from Philadelphia where he is with FMC. . . . **Norton Baron** and Pat came from D.C. where he is on rotation from Los Alamos. . . . **Jim Berman**, **Bill Edgerley**, **Don Gillespie**, and **Howard Reuter** made bachelor appearances at the Cambridge events. So did **Bob Walton**, but he went to Bermuda also. . . . **Ron Greene** has retired from GE out on the West Coast. . . . I believe **Harry Lang**'s trip from his Anchorage home was the longest of the class. He runs two companies in Alaska.

The Pops hasn't changed too much—it's still wonderful; the wine punch is just as good; there are still 5 people to a table; but the chairs aren't chained anymore. We still miss Arthur Fiedler, and now it appears we can miss John Williams too. He no sooner played for us than he announced his resignation. . . . **Bill Howlett** enjoyed the Pops: his foot kept up with the tempo all night long! He and Eleanor are another or our D.C. group. . . . **Milt Bevington** and Paula, **Bob Cowen** and Mary, **Jerry Lewi** and Loretta—from Atlanta, Boston, and Los Angeles—all had a great time. Jerry is director, business development, Guidance and Control Systems, Litton Industries; now living in Agoura, Calif.

Friday was Technology Day—breakfast in the Student Center, panel discussions on entrepreneurship, the Alumni Luncheon and all those big donations, our class picture, cocktail party, dinner, and our quintennial class meeting. The Memorial Service for alumni who have died in the past year was well-attended. For our class, sorrowfully, were listed **Guy Boucher**, **Wilbert Chope**, **Stanley Harshman**, **Allan Kriegel**, **Francis Marran**, **Robert Newman**, **Charles Sherman**, **James Stavrolakis**, and **Boynton Tucker**. The luncheon is now held in the ice arena—air conditioned and solid floored. We had coed classmates: **Elda Chisholm**, **Barbara Powers**, and **Mary Cretella**. Mary is senior chemist for Mobil Solar Energy Corp. in Waltham. She has three boys and a girl. . . . **Charles Walker** is vice-president and regional manager for C.F. Braun Co. in Houston, specializing in process plant engineering. . . . The **Kenneth Prytherches** and **Paul Ostergaards** were there.

The cocktail party and class dinner were very nice. **Fred Fletcher** and Ceil came from Parsippany, N.J., where Fred is manager of distribution services for BASF Wyandotte. . . . It was wonderful to see **Oliver Hagerman**, **Dave Hardin** and Paula, **Harold McInnis** (from AMP in Harrisburg), and **Len Newton**. Len is already planning next year's third M.I.T. alumni group trip to China. And for a pleasant night when viewing New England's scenery, stop in at Len's Autumn Inn in Northampton, Mass.

We have several first time reunioners, and one was **Mike Scholnick** who brought Millie to see what M.I.T. is all about. Mike is a sales rep in Los Angeles. . . . **Herb Spivack** came up from Rhode Island. . . . **Peter Stein** and Nancy, **Kemon Taschioglu** and Rhoda, and **Bill Wilson** were there. Bill is in Newport, R.I. with the Naval Underwater Systems Center.

At the class meeting we elected new officers for the next five years: president, **Frank Hulswit**; vice-president, **Jim Christopher**; secretary, **Barbara Powers**; treasurer, **Mickey Ligor**; and 40th gift chairman, **Tom Toohy**, taking on a tough job.

This, then, is my swan song. However, I shall write up the notes for the Bermuda portion of the reunion and send them on to Barbara so she can include them in the next column. It's been a nice five years as your secretary and during the previous years as president, 25th reunion chairman, and '49 classmate. We're a good class—you're a good group! Let's keep it going.—**Paul E. Weamer**, Ex-Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017; **Barbara F. Powers**, Secretary, 39 Mount Vernon St., West Roxbury, MA 02132

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Our 35th reunion committee announces that it has chosen Cambridge and Bermuda as the sites for next year's meeting. After attending the Alumni Association events in Cambridge on Thursday and Friday, June 6 and 7, we will then lift off for three full days in the sun in Bermuda—Saturday, Sunday, and Monday—returning to Boston on Tuesday, June 11. A wonderful time is anticipated. Further details will follow from the committee which consists of **Bob Snedeker**, chairman, ably assisted by his wife, Pat; Sue and **Mal Green**; **Margaret Coleman**; **Bill Murphy**; Helen and **Bob Wohler**; **Sam Raymond**; Jewel and **Jon Ganger**; Lucille and **Bob Cesari**; **Ruth Weaver**; **George Wetmore**; Margaret and **Bob Mann** and Dot and **Jack McKenna**. Please remember to re-

serve the above dates!

Richard N. Bolles married Carol Christen on May 19 and honeymooned in Toronto. Dick is the author of the best-selling job hunting classic, *What Color Is Your Parachute? A Practical Manual for Job Hunters and Career Changers*. An Episcopal priest, he is director of the National Career Development Project, Walnut Creek, Calif., where he also lives.—**John T. McKenna**, Secretary, 9 Hawthorne Pl., 10-H, Boston, MA 02114

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George E. Groves is currently employed as construction manager for Flood Engineers, Architects, Planners, Jacksonville, Fla. . . . **David L. Caplan**, formerly executive vice-president for Fortune Systems Corp. is now their general manager and vice-president. . . . **Lawrence A. Schneck** has a new job as information systems manager for the stock brokerage firm of Neuberger and Berman in New York City.

George H. Elmer, Jr. writes that he completed 33 years with DuPont in June. He has been designing, maintaining, and installing automatic controls for chemical plants and is currently working on a simple cycle concentration unit for a Victoria, Tex. plant. . . . **Allen B. Fonda** has been promoted to manager of Strategic Planning.—**Gregor J. Gentleman**, Secretary, 600 Holcomb, Suite 1, Des Moines, IA 50313

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Now that fall is here and many of you will be receiving requests for annual donations to the Alumni Fund, please take a few moments to jot down on the form provided a few sentences about what you are doing at work, at home, or in your community (political or professional). Most of the information I receive about our classmates is from non-personal sources such as newspapers, press releases, etc. The personal input, though, is usually more interesting.

One input is from an article in the May 1984 *Cape Cod Times*. Reverend **Betty Ann (Ferguson) Lehmann** has just been appointed a full-time associate minister at the Federated Church of Hyannis, Mass. Betty Ann graduated from the Union Theological Seminary in New York over two years ago and was ordained into the Christian ministry in December 1983.

She worked as an engineer at Westinghouse for a few years after graduation from M.I.T., married Fred Lehmann, and raised four children, during which time Betty Ann served in several lay capacities for the First Congregational Church in Boxford, Mass. and as chairman of the town board of assessors for about four years. We wish her well in her new position.

From the Tippetts-Abbett-McCarthy-Stratton (TAMS) publication "TAMSWEEK," we hear that **Michael Gruenbaum** was appointed director of administration and marketing in Boston. Mike, who also has a master's degree in city planning from Yale, has worked for TAMS before as well as for the City of Boston and several Massachusetts transportation agencies. He is a fellow of the Institute of Transportation Engineers. Mike and his wife Thelma, who is director of public information and publications for Brookline Public Schools, have three sons and live in Brookline. . . . **Thomas J. Perkins** is a senior partner at Kleiner, Perkins, Canfield and Byers, as well as chairman of Morgan Stanley Ventures, Inc. . . . **Elliott H. Lieb**, a professor of mathematics and physics at Princeton University, was among the 60 new members elected to the National Academy of Sciences in May. Congratulations, Elliott.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn**, Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

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Our 30th reunion was, as expected, a lively and most enjoyable affair. **Bob Warshawer** and his crew did themselves proud, combining the usual Night at the Pops and Technology Day activities with an outstanding class dinner, a most satisfying clambake, and a very pleasant visit to the President's House, where Priscilla and **Paul Gray** served fruit, champagne, and lots of hospitality. In between, of course, there was plenty of time for renewing old friendships.

Although it is now some four months since the reunion, this is the first opportunity to report on the event. At the dinner on Friday evening, the following class officers were elected for 1984-85: **Harvey Steinberg**, president; **Barbara Black**, **Daves Howes**, and **Sam Losh**, vice-presidents; **Ed Eigel**, secretary; **Joe Blake**, assistant secretary; **Bob Evans**, treasurer; **Bob Warshawer**, permanent reunion chairman; **Dominick Sama**, vintner. Dom, by the way, provided an ample supply of "Chateau Lateque 54 (Paul Gray Inauguration Special)" for the class dinner.

Some 84 members of the class attended at least part of the reunion. Our retiring president, **Larry Holmes**, drew up a class questionnaire, and 22 attendees submitted responses. In that small group, we find that slightly over half have changed jobs during the past five years, and two-thirds of those have changed their professions or occupations. Most have not changed their hobby or recreational habits during the same period, but among new activities reported are astronomy, skiing, sailing, piano, Scottish dancing, ham radio, estate planning, and retirement. The most frequently mentioned change in family status involved children graduating from college, although one member of the class reported a child born and one proudly announced the birth of his first grandchild.

The class, as represented by the survey sample, is doing well. Thirteen reported that their financial position has improved over the last five years, while only six are in a worse position (in most cases because of children in college). Three-quarters of the group are now more optimistic about their own individual futures, but the respondents split down the middle between optimism and pessimism concerning the outlook for society in general. About half work harder now than five years ago, and only three have been able to find a way to work less hard.

Responses to the question, "What is the most significant or prominent event in your life during the past five years?" included "Bought a backhoe, sold the bulldozer;" "Got married, acquired a cat;" "Traveled through mainland China;" "Visited India;" "Had a book published;" "Received an endowed professorship;" "Started teaching;" "Welcomed first-born grandchild;" "Retired." That, for what it is worth, is one picture of the Class of 1954, based on a small, self-selected sample.

One of the significant points brought out in the questionnaire results is that our class is actively changing jobs and even professions. In the next column, we hope to report some of those changes in the form of items about individuals. To keep the news flowing, please let us know, directly, your own latest news, job-related or otherwise.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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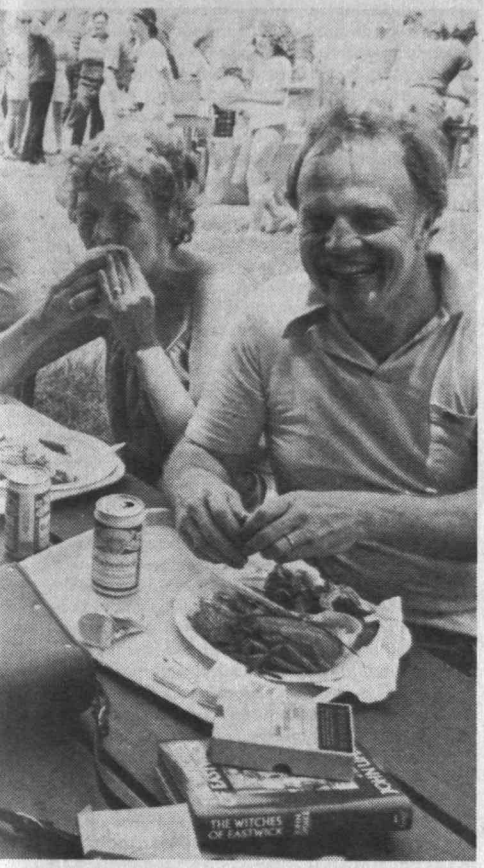
The delay in generating these notes is occasionally mind boggling. Thus it is hard to realize as I sit in a hotel in Calgary, Canada during the Calgary stampede in July, about to transmit March/April news, that this report will not reach you until October. However, better late than never-so on with the news.

1.

First, one of our most illustrious classmates, Lieutenant General **James A. Abrahmson**, the associate director for space flight at NASA, was placed in charge of the administration's "Star Wars" nuclear defense program several months ago. Jim, an aeronautical engineer by training, received an Air Force commission on graduation and flew 49 combat missions in Southeast Asia in 1964 and 1965. After attending the aerospace research pilot school, he was selected to be an astronaut with the Air Force manned orbiting laboratory program, but that program was cancelled in 1969. He was thereafter the program manager for the Maverick, an air-to-ground anti-tank missle, and later, the F-16 fighter. He has been with the space agency since November 1981 and has directed both NASA relations with Congress and the space industry and, most recently, both the space shuttle program and commercial sales of shuttle services. We look forward to reporting Jim's further accomplishments.

We have also heard of a new invention of **Lawrence G. Brown**, which may revolutionize bicycle drives. Larry is with Fort Worth Houdaille, better known as Fort Worth Steel and Machinery. He has developed a cam-like mechanism, the "ExO Power Cam," which may be retrofitted on a conventional multi-speed bike and which varies pedal resistance and permits decreased rpm's for a given speed. While we may have to refer to Larry's patent to understand his invention, the news nevertheless warms the cockles of a patent attorney's heart.

A news release from Amsted Industries of Chicago indicates that **Gordon R. Lohman**, Course III, a vice-president of the company, has also been elected a director. Gordon has spent his entire professional career with Amsted, joining its Griffin wheel division after graduation, moving to Amsted Research Laboratories in 1961, becoming director of research of that subsidiary in 1967 and



2.

3.

A highlight of Class of 1959's 25th reunion was a Boston Harbor cruise culminating in a clambake at Thompson's Island. 1. Janet Robbins (left) and Gayle and John Polhemus picnic amidst sessions of softball, soccer, volleyball, and frisbee. 2. Children and grandchildren of alumni accompanied their parents to reunions. The youth program included joining parents at Thompson's Island for a clambake, outdoor sports, and hayrides. 3. Alba Lucia and Jamie Glottmann disembark at Thompson's Island. (Photos: Frank Revi, '86)

G. R. Lohman

its president in 1968, becoming president of Amsted's Macwhyte division in 1976, and being elected a vice-president of the parent company in 1978. Gordon and his wife, Jo Ann, have two children and live in Barrington Hills, Ill.

Word also comes from **Elliot Swanson, Jr.**, Course VI, that he has started a company, Reeco Australia Pty. Ltd., to make fume incinerators for process industries. Reeco's incinerators, which provide for energy recovery as well as air pollution control, are produced under license from the Regenerative Environmental Equipment Co. Inc. (REECO) of New Jersey. The first Australian installation, valued at about $1 million is due for completion sometime this year.

Your New York correspondent had the opportunity to see **Michael E. Halpern**, Course X, in Atlanta recently. Mike is a custom home builder and is enjoying the busy social world of an Atlanta bachelor. He finds time to see his former wife, Barbara, and his two grown-up sons, and also is heavily involved in a dramatics group and in volunteer work at a local hospital.

A couple of words about your New York correspondent's recent activities-despite the occasional necessity to work, my wife Devra and I have found time during the past year to visit Peru, Sweden, England, Egypt, Israel, and now, Canada. We have been accompanied on these jaunts by varying combinations of our three children: Lisa, who is now a candidate for a Ph.D. in English literature at Columbia; David, who is studying Japanese for a year in Tokyo before returning for his third year at Yale; and Steven, a high school sophomore. Okay Allan, its your turn to update your own activities in the next report.

Believe it or not, the time has come to begin thinking about our next reunion. Would you believe number 30? Save some time next June—we will provide further anon.—Co-secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502; **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

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Thanks to **Margie Gilson** for minutes of the May 15 class meeting at the Cambridge Hyatt-Regency and comments on the alumni weekend. **Bill Northfield**, class president; **Ron Massa**, vice-president and 30th reunion chairman; **Phil Trussell**, vice-president and mini-reunion chairman; **Ted Korelitz**, treasurer; **Lloyd Beckett**, **Ralph Kohl**, and **Marge Gilson** attended the meeting. Ted reported that 258 classmates have paid their class dues and the rest are hereby reminded to please pay their $10 so the class will have funds needed to plan and organize the 30th reunion. Mini-reunions are being planned for next year in California and the New York-Washington corridor, depending on where volunteers can be found. Anyone interested in participating as regional chairman, or as a co-worker, should contact **Phil Trussell** at M.I.T.

Newport, R.I. and Mashpee, Mass. are possible 30th reunion sites. Reunion plans so far include the usual on campus activities (Boston Pops and Alumni Luncheon, at which our class gift will be presented to the Institute). A bus will leave for an off-campus location Friday afternoon, and return on Sunday after a farewell lunch. Plans for our class portion of the reunion require many more volunteers. Anyone with good suggestions or willing to help should contact **Ron Massa**.

People registering or seen at the alumni weekend included **Warren Briggs**, **Ron Clark**, **T. Guy Spencer**, **Dexter Wheeler**, **Chuck Dietrich**, **Peter Dulchinos**, **Robert Hoedemaker**, **John Morefield**, **Bill Northfield**, **Ralph Kohl**, **Harry Lee**, and **Margie Gilson**.

Murray Gerber writes, referring to the May/June class notes: "I would like to mention one tiny, insignificant correction, lest my classmates think I'm a poor businessman. The sales figure you quoted ($2 million) was intended to be the short-term goal for the newly acquired company, which has 20 employees, not for the entire company. As any novice in business knows, 94 employees generating only $2 million in sales do not work for a very successful company. . . . Shirley and I are well and looking forward to our 30th. Our son Jim is having a successful college career majoring in hedonism, partying, and beer drinking. My non-business hours are more and more filled with director type activities in CBIA, CPEC, SBANE, the local PIC, and a bunch of other alphabet soup ingredients."

Other class members meeting with advancement and success in their careers include **Martin Chetron**, who is a regional vice-president for an international property management company with responsibility for the management of over 5 million square feet of shopping centers and industrial buildings. With both children having graduated from the University of California, Marty and Jane are enjoying their empty-nest freedom. . . . **Robert F. Santos** was appointed

vice-president for customer service and billing for AT&T Communications as of March 1, 1984. I think we should ask Robert to make a presentation at our next reunion, "The Decoding and Interpretation of One's Telephone Bill." . . . **Art Sirkin** is now vice-president and corporate counsel for Northville Industries Corp. of Melville, N.Y. Art's first job with the company was to supervise the construction of the first and only transcontinental pipeline on the North American continent. However, it is not the longest pipeline on the continent, since it was built across the Isthmus of Panama. The pipeline is now used to trans-ship Alaskan crude to refineries on the East Coast. To accomodate both Art's and Belinda's busy schedules (Belinda is assistant editor of *Genetic Engineering News)*, the Serkins maintain households in both Manhattan and Northern New Jersey.

Nelo Sekler has decided to go back to work. He has invested the proceeds of the sale of Oxy-Metals Finishing to Occidental Petroleum in a new venture which will make process cheese from casein. I learned of this from Nelo's wife, Eva, who spent the last two weeks of June attending a refresher course in internal medicine at Harvard Medical School. Eva is head of the Department of Internal Medicine at the Centro Medico in Caracas. Eugenia, their elder daughter, apparently intends to continue a family tradition, and will enter medical school in Caracas later this year. . . . **Richard Miller** has one son who is a senior at Virginia Tech and a second son who is a junior at William and Mary, earning his tennis scholarship by being the No. 1 player on the team. . . . **Robert A. MacDonald, Jr.**'s son, Andrew, will enter M.I.T. next fall as a member of the class of '88. . . . **Ward Halverson**'s son, Peter, is a Ph.D. candidate in physics at the University of Arizona. . . . **Ed Zoolalian**'s eldest son, Jim, will be starting at University of California Los Angeles this fall. His daughters, Pam and Linda, are still in high school. Linda is still winning many awards as a pianist and composer. Ed is still with Neff Instruments. Denise and Ed had the pleasure of having **Wendy Reis** as a weekend guest at their beach home in Oxnard last February.

There are also some sad tidings. I received a note from Mrs. Barbara Alter informing me that our classmate, **Robert D. Alter**, died of lymphoma on March 21, 1984, after a three-year struggle to overcome this dreadful disease. In her note, Mrs. Alter mentioned that her husband had been very fond of M.I.T. and had many good friends there. While we were aware of Bob's illness, his death still comes as a shock. On behalf of the class, I would like to extend condolences to Mrs. Alter and their three children, Jay, Michael, and Allison.—Co-secretaries **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617) 729-5345; **Caroline D. Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303) 794-5818

58

Despite all the advances in telecommunications technology, the election campaign will be drawing to a close as you read this column, even though it is only beginning as I write it. We will see if my scientific election poll of taxicab drivers during my travels across the country proves as correct as it was in 1984(???). Meanwhile, the mails continue to bring news of classmates' activities. Among this month's newsmakers is **Greg Lazarchik**, who received the Best-Paper-of-the-Year award for 1983 from the Chemical Marketing Research Association. Greg is director of planning and commercial development for the PPG Industries Chemicals Group in Pittsburgh. He presented a paper, "Marketing Reasearch and the Marketing Plan," last spring.

The American Institute of Chemical Engineers (AIChE) has named **Elisabeth M. Drake** as a fellow of the organization. She is the second woman in AIChE's 75-year history to receive this honor. She was recognized by the AIChE Council for her expertise in cryogenics and hazardous materials risk management, as well as for other accomplishments including work on the design, construction, and testing of heat-flux probes for the Apollo space program. Currently, she is Cabot professor and chairman of the Department of Chemical Engineering at Northeastern University, and previously was with Arthur D. Little . . . At Ithaca College in New York, **Ahren Sadoff**, professor of physics, was awarded a Dana fellowship for the current year. This fellowship honors outstanding faculty members for their accomplishments in teaching and research . . . **Howard Salwen** has now assumed the duties of chairmaan of Proteon Associates in Waltham. He had previously served with the company as its president.

During the past spring, the board of alderman of Chelsea, Mass. adopted a resolution expressing the city's appreciation to **Burton Figler** for his services to the community. He has been active in a number of educational, charitable, and religious organization activities and has also served as chairman of the United Way Fund . . . Barbara and **Mark D'Andrea** have two daughters starting at the University of Massachusetts in Amherst in the fall, in addition to having their son continuing at the University of Alabama in mechanical engineering. Mark is currently working on the development of adaptive controls for welding of jet engine components at General Electric in Lynn, Mass.

Among those listed in the first edition of the *International Who's Who in Engineering* is **Robert Baber**. Although Bob and Ursula live in Germany, they visited the U.S. during the past summer. Bob is a consultant in software engineering and has published a number of articles in leading technical journals in Europe, as well as in the U.S. When not consulting, Bob can be found scuba diving or backstage in amateur theatrical groups . . . **Matt Smith** is a metallurgical engineer with Handy and Harman, where he has developed a vacuum refining process for silver-tungsten scrap. Although Matt and Elma have four children, they attended the 25th reunion and also manage to find time to participate in a ski club near their home in Fairfield, Conn. . . . That's all for this month except for a reminder from the late Mayor Daley to vote early and often.—**Michael E. Brose**, Secretary, 59 Rutland Sq., Boston, MA 02118

59

Welcome to a new series of class notes being brought to you by the recently elected secretarial troika of **Art Collias**, **Myer Kutz**, and **Ron Stone**, also known as the Boston Latin School writing team!!! With this team format we will attempt to keep a steady stream of class notes heading your way, but as you know it's a two-way street—so keep those cards and letters coming. Feel free to send your news to any one of us and we will see that it's included. We would like to acknowledge the fine efforts of our outgoing secretaries, **Larry Laben** and **George Barnett**. They did a commendable job on a time-consuming and unenviable task.

I would like to use this column to highlight the events of our recently held 25th reunion. In summary, the event was AWESOME and everyone came away with good memories and eager to attend the 30th. The reunion was held during an unusual heatwave in which all-time record temperatures were reached each day (97-99 degrees F.—mucho caliente!!). Registration took place at our dormitory for the reunion-500 Memorial Dr. (one of the newer dormitories)—and a hospitality reception was held in the main lounge with beer and wine, cheese and crackers, and a formally attired string quartet providing that "touch of class." It was an elegant beginning under the supervision of **Dave Packer**. Following a sumptuous buffet dinner in the dormitory dining room replete with flowers and fancy linen at each table, the class was bussed to Symphony Hall for Tech Nite at the Pops. John Williams conducted an outstanding program climaxed by the Pops' special rendition of "Arise Ye Sons of M.I.T." Busses returned us to the Faculty Club for a post-Pops reception which included an open bar of cordials and liqueurs and a dessert table which included strawberry shortcake, cheesecake, and hazel nut tortes.

Friday's schedule consisted of a Technology Day program on entrepreneurship, which included as a panelist **Bill Poduska**, president of Apollo Computer Inc. This was followed by the T-Day luncheon at which the Class of '59 presented the Institute with its class gift, $758,000. The class of '59 had 63 percent participation, which is a record for 25th reunion classes. **Bob Muh**, reunion gift committee chairman, and his entire committee are to be commended for an outstanding effort.

Following a special reception hosted by Priscilla and Paul Gray in the beautiful courtyard of the President's House, the class held it's dinner-dance at the new Westin Hotel in Copley Place. A plush facility, gourmet food, and mellow music for dancing made for a memorable evening. **Larry Bishoff**, **Jack Fischer**, and **Ed Vrablick**, who planned this affair, "did good."

Saturday began with a Boston Harbor cruise culminating in a clambake at Thompson's Island. Clams, lobster, chicken, hamburgers, corn-on-the-cob, and watermelon were eagerly consumed in-between some lively sessions of softball, soccer, volleyball, and frisbee. Highlighting the afternoon was a fly-by of a plane towing a banner welcoming the M.I.T. reunion classes. Another boat ride back, a bus ride to the dorm, a quick shower and change of clothes, and we were off to the Science Museum for our class dinner. The museum provided an entertaining illusion show followed by a dinner in the panoramic (but somewhat warm) Skyline Room. The traditional awards were presented for classmates who came the farthest, **Adul Pinsuvana**, Indonesia; drove the farthest, **Bill Bassichis**, College Station, Tex.; most grandchildren, **Mike Nash**; most hair, **Dave Cahlander**; and least hair, **Lynn Sykes**; loudest sport coat, **Ed Safran**; and most recently married, Yvonne and **Frank Rising** (who were on their honeymoon). A new slate of officers was also elected to serve for the next five years. These are: president, **Bob Muh**; executive vice-president, **Allan Bufferd**; vice-presidents, **Bruce Blomstrom**, **Mike Drew**, **Walt Humann**, **Barry Weinberg**, **Adul Pinsuvana**, and **Marty Zimmerman**; treasurer, **Jack Fischer**, secretaries, **Art Collias**, **Myer Kutz**, and **Ron Stone**; reunion chairman, **Dave Packer** and **Chuck Staples**. And finally, **Allan Bufferd** presented the results of the class questionnaire. A picture book with the short class questionnaire along with a class address directory was also handed out during the reunion. Those of you who would like to receive these two interesting documents can receive same by sending in your class dues ($25) to me at the address below.

A getaway Sunday brunch in the dormitory completed the reunion program. During the next few issues of class notes, we will try to include some anecdotal impressions of the weekend and classmate information gleaned during the reunion. We would like to acknowledge the outstanding job and hard work put in by the reunion chairman **Chuck Staples** and his committee. I would like to add my personal thanks to all of you who made my tenure as class president such an enjoyable and memorable experience. I look forward to keeping in touch with you through these class notes and working with Myer and Ron to make them interesting and informative. Until next time. . . . SAYONARA.—**Art Collias**, Secretary, 24 Hemlock Dr., Canton, MA 02021, (617) 828-5073

60

Barry Bronfin writes, "I am thoroughly enjoying my reunion with many bright and talented mem-

bers of the class of '60, as part of my efforts to build our reunion gift campaign to the largest and most successful ever for M.I.T. The class project, as selected by the members of the reunion gift committee, is an endowment for innovation in education—to provide support for curriculum development throughout the various departments of the Institute.

While not working on this important campaign, I serve as president and chairman of Scientific Leasing Inc., a lessor of selected technologically advanced equipment to the nation's healthcare communities and industrial research and development laboratories. Scientific Leasing is headquartered in Farmington, Conn. and would welcome the opportunity to assist worthwhile enterprises of M.I.T. alumni.

I am living in Wethersfield, Conn. with my wife Cecile and children, Michael (16) and Wendy (14). Frequently the family can be found aboard our sloop, the Winphyn, sailing Long Island Sound."

From **Joe Verderber**: "The Verderber family is doing a second "tour of duty" in New Jersey. Since January 1982 Joe has been president of the Varityper Division of AM International. Joe and Anita are now living in Summit with sons, Joe Jr. and Paul. Joe Jr. is working as an accountant, while Paul is finishing his junior year in high school. Daughter Lisa is entering her junior year at Duke. Joe recently ran into Jeannie and **Milt Reed** in Tulsa. They are in the process of moving to Warsaw, Ind. . . . **Brian O'Connor**: "After graduating in 1960, studied organic chemistry at the University of Illinois and received Ph.D. in 1964. Joined DuPont Co.'s Central Research Department in Wilmington and over the last 20 years have had assignments in R&D, sales, and marketing. Am currently director of marketing for the printing systems division, located in Wilmington. Wife Linda and I have just finished building a "Colorado contemporary" (like a ski condo but no hill!). Now busy with landscaping. Play tennis and a little golf and read a lot. We have lots of room in new house and would be happy to put up northerners on their way to Florida or visa versa."—*S.K.* (**Noel S. Bartlett**, Secretary, 15320 Edolyn Ave., Cleveland, OH 44111)

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Jerry Grossman, president of the New England Medical Center, was elected to the Institute of Medicine last year. It's a great honor, akin to the National Academy of Science. A belated congratulations. Jerry. . . . **Bill Dryden** is director of business development for Hublein Spirits and Wine Co. in Farmington, Conn. . . . **Bernie Goldhirsh** is in the news again. As you recall, Bernie is the spectacularly successful publisher whose stable includes *Inc.* magazine. He and Boston developer Mortimer Zuckerman were reported to have offered $150 million for *U.S. News and World Report* in late May. Bernie says *Inc.* has only a quarter the circulation of *U.S. News*, but "We're more profitable."

John Reed's picture was prominently displayed on the local front pages for several days last June. First came the rumors of his impending appointment as chairman of New York's Citibank, then the appointment itself, and finally a couple of articles on how the appointment came about. This interest reflects the importance of his position as head of the largest bank in the U.S. Citibank nosed out Bank of America for that title about a year ago. John has several major successes at Citibank. One was cleaning up the paper shuffling parts of the operation some years ago. More recently he has been in charge of the consumer division which includes the electronic teller operation and the charge cards section. Those mailings we have been getting on the value of buying a Citibank MasterCard all originated with John's operation. Now he is in charge of the whole works. Its one of the most important business positions in the country, and we all wish him well. Congratulations, John.

Island picnic. In addition to the scheduled Technology Day activities, Class of 1964 chose a visit to John F. Kennedy Library, a Thompson Island clambake, and a dinner/dance at the Museum of Science to round out their 20th reunion. (Photo: Frank Revi, '86)

Captain **Millard Firebaugh** remains in the navy with responsibility for the acquisition of the latest attack class submarines. He also says he supports the activities of his family: wife Barbara, who teaches the hearing impaired, Josh, 14, and daughter Samara, 10. The whole crew lives in the Virginia suburbs of Washington, D.C. . . . **Tom Hasting** writes that he is happy at Digital Equipment Corp. working on terminal architecture. He goes on to say, "Jessie, our daughter, will be 3 in September and is learning to swim. Bonnie is trying freelancing after a successful career as a newspaper reporter." . . . **Dave Pratt** writes that he became the president and CEO of Boschert, Inc. a year ago. They make switching power supplies for all sorts of things including the computer on which these notes are being written. Thanks and congratulations, Dave. . . . **John Haggert** is a fellow of the American Ceramic Society. John is still at M.I.T. working in the Energy Lab, where he is program manager for advanced materials in the materials science department.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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Scott Danielson writes that he has been promoted to technical director for architecture at Parsons Brinckerhoff. He recently finished the conceptual design for a Department of Energy proposal for a superconducting particle physics research facility. . . . **Larry Hoffman** is married with a 2-year-old daughter and lives in Montclair, N.J. He is a partner in the law firm of Darby and Darby, specializing in products liability defense. He would like to hear from classmates in the New York City area. . . . Evidence that someone actually reads this column is provided by **J. Ladd Howell**, who is in real estate in Florida. He responded to **Ed Feustel**'s request to know about East Campus residents of our area. Ladd's address is 7350 Poinciana Ct., Miami Lakes, FL 33014, and he also mentions that **John Bailey** lives at 32 Ferry Rd., Fredericksburg, VA 22405.

A copy of the *Texas Tech News* was sent to me reporting that Professor **David B. Knaff** of their chemistry department has been elected a fellow of the American Association for the Advancement of Science. David has been at Texas Tech since 1976 and has served as chairman of the biochemistry division. . . . Commander **Michael Terry** is currently deputy supervisor of shipbuilding in Seattle. He plans to retire from active duty in January and remain in the Seattle area.—**John Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

63

Would you want your daughter to go there? Or your son? We've all been out of the Tute about 21 years. We've had a chance to measure an M.I.T. education as it has applied to our own careers, and compare it to other colleges where our professional colleagues and others went. Now that many of our offspring are considering colleges, what, if anything, should we tell them? Does the decision depend on your daughter's career choice or your son's personality? Send your answers, in light of your own career development, for publication in our column. (I reserve the right to edit for clarity and brevity if necessary.) This issue's mail is brief: **Herb McClees** has set up a consulting company, InnerTek, in Mill Creek, Wash. He produces two product lines—a Forth real-time system and "Peopleware," a program apparently teaching the user to set up and facilitate quality circles. Herb also reports that his daughter Johanna is now 5 years old. He wonders if she will be a member of the Class of '01. . . . **Patricia White** is a supervisory chemist with the U.S. Pharmacopoeia. Her son Edward has completed his third year at West Point, and son James is in second grade. . . . **Donald Knutson** and Andrea Allen Knutson, '65, happily tell us

they had a daughter on February 20, 1984. Their 14-year-old-son, then studying *The Tempest* (Shakespeare's last comedy) in English class, suggested she 'be named Miranda after the heroine of the play, and she was.

And that's the news; thank you for looking in. Please write.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218

64

Greetings and happy post-20th reunion wishes to all. I am pleased to be participating in my first edition of class notes as the new '64 secretary. Our reunion was enjoyable, well-attended, and I believe judged to be a success by all who participated.

The majority of this column is a result of the efforts of our departing secretary, **Steve Schlosser**. He writes, "Dear classmates: thank you for the privilege, trust, and pleasure of being your secretary these past ten years. As you can tell from the increased frequency of missed columns, even the most enthusiastic letter readers and class notes transcribers can run out of gas; I have, and it is time for a change. It has been a truly wonderful experience.

"**Robert Muhr** is now manager of industrial relations for Hydranautics, Inc. of Goleta, Calif. His address and phone for interested classmates is 739 Dorado Dr., Santa Barbara, CA 93111, (805) 964-7330. . . . **Mike Monsler** has recently moved from Oakland, Calif. to Ann Arbor, Mich. with wife Barbara and children, Eric (4) and Kari (12). Mike is vice-president for Fusion and Laser Research at KMS Fusion, Inc. It seems that the Monsler family was ready for new adventures and challenges, even though people told them leaving California was failing a test of sanity. The children love their new schools, and Barbara is doing well as a product manager at ADP Network Services. Mike said they miss their friends, particularly **Michael Laidner** and **Jerry Burnett**, whom they often saw in the Bay area.

"An AIA Architects Award for the United Artists Galaxy Theater was awarded to the San Francisco architect firm, Kaplan/McLaughlin/Diaz. **Jeffrey Heller** was partner in charge of the award-winning project. Heller stated the design was intended "to create a new sense of excitement about going to the movies." . . . An ATE (Automatic Test Equipment) lecture series featured **Peter Staecker**, a staff member at M.I.T. Lincoln Laboratory's Satellite Communications Division. As your about-to-be-ex-secretary is a career-long participant in the ATE industry, it is gratifying to see IEEE and M.I.T. involvement in the field. . . . For the last time, ciao from **Steve Schlosser**."

On behalf of all the Class of '64, hearty thankyous to Steve and his wife, Marlene, for ten years of effort in putting together these columns and helping promote communications between classmates. Steve and his predecessor, **Ron Gilman**, leave big shoes to fill. With your cooperation-please, please send lots of letters—I'll give it a try.—**Joe Kasper**, Secretary, TASC, One Jacob Way, Reading, MA 01867, (617) 944-6850

65

I have been doing this column for almost ten years (with a break) and I think I have experienced a first this month. See if you can tell what it is.

Barbara Vickers writes that she is spending most of her time involved with Bill, 9, and Brian, 5, and as chairman of the Hollis kindergarten board. Harry has opened an Entre Computer Store in Nashua, N.H. . . . Dr. **Mary Coffey** reports that she continues to work in the environmental group at Bechtel in San Francisco. Mary says that the weather beats Boston's during the winter (I believe it!). She is enjoying both the cultural benefits of the city and the beauties of the countryside. Mary is still adjusting to the (more human) practice of queueing up for boarding BART, Muni, or buses rather than "rushing the door" that occurs on the "T" in Boston.

Andrea Allen Knutson writes that she and Donald Knutson, '63 had a daughter on February 20, 1984. She has been named Miranda at the request of her 14-year-old brother who was studying *The Tempest* in his English class. . . . **Margaret (Scotty) MacVicar**, Cecil and Ida Green Professor of Education and professor of physical sciences at M.I.T., presented the Phi Beta Kappa oration "Choices, Character, and Chimeras" at Harvard's 333rd commencement last June. . . . **John Kassakian**, who has focused on the "heavy current" side of electrical engineering from power semiconductors to rotating machines, has been promoted to full professor at M.I.T.

Did you get it? As I recall, we entered with about 20 women in a class of about 900. I can't do the odds of four items about women of five items in a column, but they must be small. Sadly the odds of a column with only five items seem to be pretty large. You could always write me a note.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

67

Eileen Tate Cella has dual careers—she teaches computer science, math, and statistics at Guilford Technical Community College, and is also the administrator for Corporation of Guardianship, a non-profit organization that serves as guardian for persons declared mentally incompetent and for whom no relative or friend is available. Eileen has completed course work for a Ph.D. in family relations and child development, and also serves on the M.I.T. Educational Council. . . . **Marc Schulman** recently joined Hambrecht and Quist, a venture capital and investment banking firm specializing in high technology companies. . . . **Richard Chappell** teaches computer science at the University of South Carolina and hopes to make the transition to industry in the near future.

Bill Thilly has been appointed to a full professor at M.I.T. in the Department of Nutrition and Food Science, where he has developed multifaceted research programs in genetic toxicology and mammalian cell technology. Bill joined the M.I.T. faculty in 1972. His primary research goal is to devise means to determine the causes of genetic change in humans. Workers in his laboratory are using several approaches to finding "fingerprints" of mutagenic chemicals in human blood cell cultures. He is deputy director responsible for research coordination of the M.I.T. Center for Health Effects of Fossil Fuels Utilization in which combustion engineers, analytical chemists, and toxicologists work together to identify components of soots capable of causing biological harm.

Donna Page Sytek, wife of **John Sytek**, is a New Hampshire state representative and chairman of the New Hampshire Republican Party. Donna has a biology degree from Regis College in Weston. She and John met at a mixer while John was at M.I.T. and were married in February of 1967. They have a charming 14-year-old daughter Mary and live in Salem, N.H. Donna recently traveled to Zimbabwe to observe as representative of the U.S. Republican Legislators Association.—**Jim Swanson**, Secretary, 878 Hoffman Terr., Los Altos, CA 94022

68

The spring of 1984 seems to have been a good time for classmates to make the national press. The April 30 issue of *Time* had on the cover a smiling Chinese youth standing on the Great wall holding a Coke. If you noticed the credits, you would have seen that the photographer was **Owen Franken**, who also had several pictures in the cover article on Reagan's trip to China. . . . The May *Scientific American* included an article, "The Inflationary Universe," co-authored by **Alan Guth**, who originated an alternative theory to the better known, at present, "big bang" theory. . . . **Gerald Sussman**, who has been on sabbatical at Caltech "playing astronomer," has been promoted to a full professor at M.I.T. in Course VI. He recommends that "everyone should get a one-year chance to play out a fantasy!"

Ken Morse has joined forces with Fred Luconi, '67, as vice-president of marketing at Applied Expert Systems (APEX), Inc. in thriving Kendall Square, just across from the F&T Diner (remember?).

Rick Karash has recently joined APEX as vice-president of product development. APEX supplies expert system work stations to the financial services industry. Ken describes their machines as operating "in such a way that if the machines were human we would say their behavior was intelligent." . . . **Bob Metcalfe** at 3Com Corp supplies them with Etherlink local computer networking boards and software.

In the Big Apple, **Richard Raysman** is practicing law with the firm of Brown, Raysman, and Millstein. He recently co-authored a book, *Computer Law: Drafting and Negotiating Forms and Agreements*. . . . In Swampscott, **Alix Smullin** is running for re-election to the school board, a contest that will have been long ago decided by the time you read this. Alix received a law degree from Boston University in 1972 and practiced law for six years before turning her full-time efforts to her family and community. Alix and Joseph have three children: Sam, 7, Rachel, 5, and Sarah, 4.

Richard Fox and two other Westinghouse executives have purchased Westinghouse's factory automation business located in Orlando, Fla. The new corporation is Automation Intelligence, Inc. It has 150 employees and manufactures robot vision, robot controls, and other products for factory automation. . . . We are sad to report the death of **Victor Blanco** on October 16, 1983, when he was killed by parties unknown in Tucson, Ariz. At the time of his death he was associated with the Observatorio Interamericano in La Serena, Chile. Our sincere condolences to his family and friends. . . . That's about all we have for this month.—**Gail** and **Mike Marcus**, 8026 Cypress Grove Lane, Cabin John, MD 20818

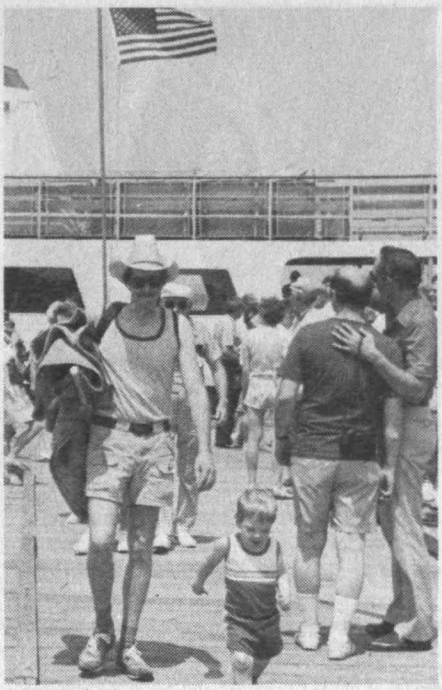
69

After an unusually strong turnout for a 15th reunion, with 5 percent of the class participating, '69 returns to these pages. At the reunion's concluding Sunday brunch new class officers were elected: president, **Ross Hunter**; vice-president, **Robert Wiener**; treasurer, **Jeff Lepes**; class agent, **Paul Beckerman**; and secretary, **Eugene Mallove**. We're going to turn over a new leaf and try to have these notes appear more regularly.

Steven Eriksen is now the executive vice-president of Cambridge Decision Support Group, a management consulting firm located in Concord, Mass. . . . **Henry G. Baker**, one of the founders of Symbolics, Inc., now involved with workstations for AI systems development recently spoke at the M.I.T. Club of Southern California. . . . **Robert Schaeffer** reports moving into a new house in Belmont, Mass. and a new job as editorial director of WBZ-TV, Channel 4 in Boston. Bob has a new book out: *Running to Win State and Local Elections*. . . . **Alan Willsky** and **Alan Grodzinsky** are now full professors in M.I.T.'s Department of Electrical Engineering and Computer Science.

From Bloomfield Hills, Mich. **William Nemeth** reports being promoted to director of domestic sales for the Intercolor Division of Intelligent Systems Corp. . . . **Larry Viehland** is professor of chemistry at Parks College of St. Louis University. . . . Wife **Claudia Winters Viehland** is an instructor of chemistry at Chaminade College Preparatory School in St. Louis. The Viehland sons, Jeremy (10) and Brian (7) are thriving. . . . **Rexford Stark** received his Ph.D. in chemistry

Class of 1969 had an unusually strong turnout for a 15th reunion, with five percent of the class participating, 57 classmates plus wives and guests. Above: '69ers tour Boston Harbor.



Lee Dilley, '69, disembarks at Thompson Island with son Paul, Class of 2003. (Photos: Frank Revi, '86)

from Stanford back in 1975 and now has his own company, Rex Stark Americana, which publishes mail order catalogs of all kinds of collectibles, from 18th century to present. . . . **Donald Collins** passed his board-certification exam in obstetrics/gynecology and is now with the Marshfield Clinic. . . . **Sumner Rosenberg** is an attorney with an Atlanta law firm and specializes in patent law, environmental law, and nuclear utility law.

Peter Kleeman is living in Charlottesville, Va. and will be teaching management science at the University of Virginia's McIntire School of Commerce. Peter is actively involved in the music and dance life in Charlottesville, dancing at festivals from Vermont to North Carolina with the Albemarle Morris Men. . . . **Richard Hessdorfer**, formerly with Computervision Corp., has joined Formative Technologies, Inc. (FORMTEK) as director of marketing. FORMTEK is a Pittsburgh based company which develops CAD systems for the architectural, engineering, and construction markets.

Major **George Slusher** is now at Andrews AFB, Md. in the headquarters of the Air Force Systems Command, working on long-range planning for the Air Force Space program. . . . From Palo Alto, Calif. we hear that **Russell Molari** has been named vice-president of the newly established Software Engineering Services organization of Informatics General Corp.'s Professional Services Operations/West. Struggling with the new "deposit law" in New York is **Bill Bengen**, who is executive vice-president of the family 7-Up bottling corporation, serving over seven million people. . . . **Stanley Goldin** is doing brain research at Harvard Medical School as an associate professor. . . . **Alan Millner** is executive vice-president and co-founder of Trisolar Corp., a photovoltaic systems company with recent jobs in Tunisia and Bermuda.

Kathryn Kanarek James has been working for the U.S. Army at Ft. Leavenworth in the area of tactical communications. She lives in Kansas City and would like to hear from classmates who might be in the area. . . . **Jim Ebright** reports ecstatically that his company, Software Results Corp., made the INC 500 list. . . . **Randall Hekman** claims to have more kids than any other classmate—seven with one more on the way (all with first and only wife). Randy is still a juvenile court judge in Grand Rapids, Mich. and "finds life exciting." . . . **James Kornberg** and wife Sally are delighted to announce the birth of Terra, their third daughter. Jim reports that his occupational medicine and toxicology practice is flourishing in the Boulder/Denver area. . . . **Susan Udin** is now an assistant professor of neurobiology in the medical school of State University of New York at Buffalo. Susan says, "Despite its awful reputation, Buffalo isn't a bad place to live. . . . houses are astoundingly cheap."

In subsequent issues I'll try to publish the backlog of class news that has been building up this year. Right now I'm busy writing space-oriented science articles for the *Washington Post*'s "Outlook" section plus a self-syndicated newspaper column, Starbound. By day I do pattern recognition work at M.I.T. Lincoln Laboratory, by night I do astronomy. Keep those notes coming.—**Eugene Mallove**, Secretary, 215 Highland St., Holliston, MA 01746

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Marvin Greenberg has been practicing ophthalmology in the Fort Lauderdale, Fla. area. He lives in nearby Coral Springs with his wife and two daughters. . . . **Andre Cappon** has recently become a principal of Booze, Allen, and Hamilton, management consultants. . . . **Chris Cross** is with Sun Energy Systems and Equipment in Pittsfield. He has been in the solar business for more than eight years and is involved in homes, greenhouses, and energy efficient windows.

It has come to my attention that **David Smith** of Englishtown, N.J. passed away in November 1983. . . . **David Hu** of Berkeley, Calif. died in April 1980.

Karen and **Greg Arenson** announce the birth of Morgan Elizabeth in May 1984. The Arensons live in New York City where Karen has taken six months off from her job as an economist and financial writer for the *New York Times* to nurture the growth and development of their child. Greg is a partner at Schwartz, Klink and Schreiber. They live on the west side of Manhattan and see the Grochows and Wendy Erb, '72, on occasion.—**Robert O. Vegeler**, Secretary, Dumas, Backs, Salin, and Vegeler, 2120 Ft. Wayne Natl. Bk. Bldg., Ft. Wayne, IN 46802

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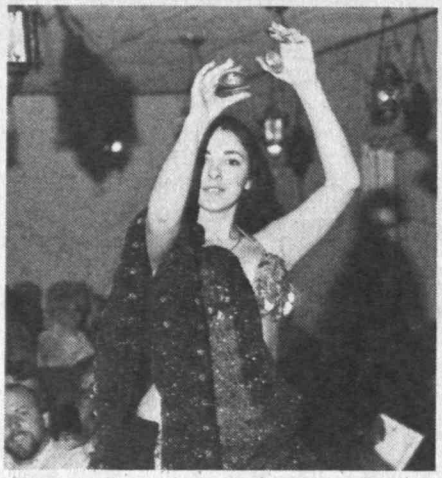
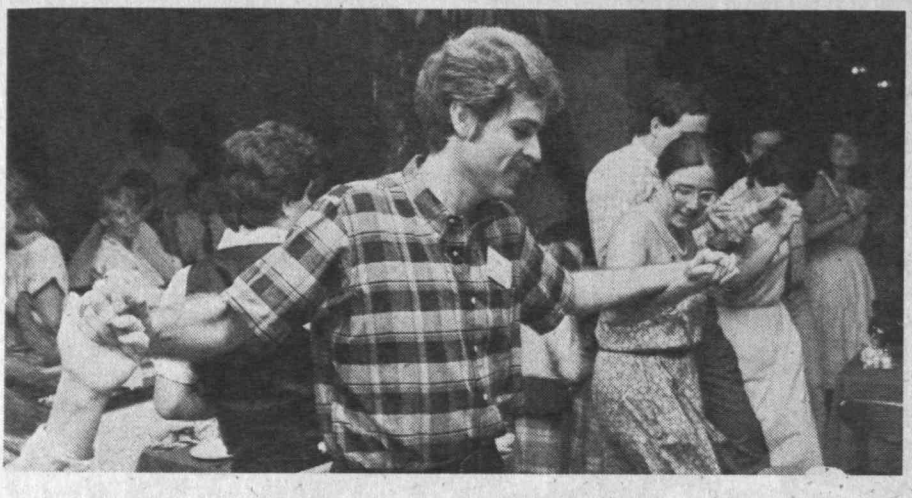
Philip Martel married in September 1983 the former Marlene Kennedy of Pittsfield, Mass. . . . **Steven Givot** is running for U.S. Senate on the Libertarian Party ticket. . . . **Fred Middleton** is president, Morgan Stanley Ventures, Inc., a subsidiary of Morgan, Stanley and Co. . . . **Howard Jay Siegel** is an associate professor of electrical engineering at Purdue University. He is directing a group building a 30-processor prototype of the PASM dynamically reconfigurable parallel processing system. This June he spent two weeks in Peking, China attending the First International Conference on Computers and Applications. . . . **Timothy J. Maloney** is now with Intel Corp. in Santa Clara, Calif., after spending several years in the research labs at Varian Associates in Palo Alto.

John R. Hauser has been promoted to full professor at M.I.T. Professor Hauser is a management scientist whose research and teaching are in marketing. Hauser taught at Northwestern and joined the Sloan School faculty in 1980. He is known internationally for his research in new product development and mathematical models of consumer behavior. Recently, his work in defensive marketing has opened a new area of fundamental inquiry. He has developed a formal





Saturday evening (June 9) reunion activities for Class of 1974 included dinner at the Averof Restaurant complete with belly dancer (above left). Lionel Goulet, '74 class secretary, and Sandy Yulke, '74 class president (above right) try Greek dancing. (Photos: Frank Revi, '86)

normative theory based upon a well-grounded model of market response and recently completed an empirical test of the theory. His graduate text, *Design and Marketing of New Products* (with Glen Urban of M.I.T.) has been adopted widely at major universities.—**Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

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The software business is booming, as demonstrated by a number of alumni activities: In June, **Christopher F. Herot** left Computer Corp. of America to found Fulcrum Corp., a software startup in Cambridge. Linda and Chris now have two boys, Eric (3) and Gregory (1). . . . Lynn Lazer Cohen (Simmons, '72), wife of **Seth Cohen**, writes that Seth is still with Digital Equipment Corp., now as a consultant software engineer working on graphics software for DEC's Professional series of personal computers. Lynn does free-lance writing and editing for a promotional group at DEC. Their daughter, Rachel, now in kindergarten, is a joy. She's a fan of the Redskins and the Celtics, and wants to learn how to play bridge. . . . Chris, Gregory, and **Paul Hendrickson** recently moved into their custom-designed home in Boxford, Mass. Paul is continuing his management consulting activities for large banks, while serving as a principal in A.P.T. Developments Corp., a new firm specializing in computer-based training.

Preston R. Ford's son, Carter Barrett, celebrated his second birthday on February 2, and continues to set the household standard for love of life. Candice and Carter enjoy the quiet charm of Marblehead. Preston's working hours are spent with Boston Investment Systems, a partnership he founded to provide systems consulting to investment managers. . . . **Brad Billetdeaux** has now transferred to Houston, Texas, with Exxon Co., U.S.A. His new job is operations research and decision support systems coordinator in the Refining Department. . . . **Richard H. Solbrig** is a project engineer for John Carollo Engineers in Walnut Creek, specializing in environmental engineering projects. He and his wife Stella are parents of Andrea (5) and Matthew (3).

Several other proud parents have written about their new families: **Chuck Hafemann** and his wife, Cindy, had their first child, a son, Derrich August Hafemann, on September 20, 1983. . . . Ann and **Ed Rich** are looking forward to a summer of fun with their 1-year-old daughter, Ashley. Ed's work continues to go well, as evidenced by his recent promotion to manager of leasing for Dow Chemical U.S.A. . . . **Charles F. Gronauer** was engaged to be married on June 9, 1984, to the former Nobuyo Shimono, of Japan. By the time you read these notes, the wedding should have occurred.

Charles Michal and Paul Pietz have announced their partnership—Pietz and Michal Architects—and the opening of their offices at 20 West St. in Keene, N.H. Previously, Charles was one of five owners of the former Equinox, Inc., of Peterborough. He is an architect and engineer licensed in New Hampshire. He has designed custom residences and commercial projects, and consulted as an energy expert on architectural projects nationwide. In addition, he writes computer programs to help solve architectural problems. He has lived and worked in the Monadnock region of New Hampshire for ten years. . . . **Rafael Bras** has been appointed to a full civil engineering professorship at M.I.T. He is a leading hydrologist, specializing in the interpretation of natural phenomena as random functions. He was named head of his department's Water Resources and Environmental Engineering division and director of the Ralph M. Parsons Laboratory. . . . **Susan Faye Steinberg** is one of the recipients of the first Squibb Cardiovascular Fellowship, designed to help promising young physicians further their careers in cardiovascular medicine. She will receive financial support of her research for the next two years. Susan is an instructor at the College of Physicians and Surgeons at Columbia University in New York. The principal area of her proposed research is the cellular mechanisms of alpha-adrenergic catecholamine action.

Sadly I must announce that **Michael Sims** died on December 19, 1982. He had been living in Evanstown, Ill., before his death. We just received the belated news.

I've just returned from a short business trip to Japan. I was there for less than a week and suffered no jet lag in either direction, so I highly recommend the newly popular anti-jet lag diet.—**Wendy Elaine Erb**, 531 Main Street, Apt. 714, New York, NY 10044

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Skimpy news this month. **Doug Luther** is assistant research oceanographer at Scripps Institute, specializing in real-time in-situ wave studies from small translating fiberglass platforms. . . . **Tom Stagliano** "finally made it to the West Coast." His company, Kaman AviDyne, sent him as an aeronautical consultant. He will be there two years, but despite the location shift, he's still refereeing college soccer and playing hockey. He thanks the Los Angeles alumni group for its help in their settling out there.

Little new in Virginia. What's new there?—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill", 1302 Churchill Ct., Marshall, VA 22115

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What a *wonderful* time at the reunion! The sun was hot, the pool was cold, the food was good, and that belly dancer could really wiggle. I am constantly surprised how many nice people there are in our class whom I never knew as an undergraduate.

Perhaps the farthest-travelled reunionites were Sue and **Steve Jordan**, from Los Angeles. They're expecting child number two in the early winter. . . . Steve's working for McKinzie and Co., telling clients where to spend their money and how to save their business. . . . Cindy and **Ron Frere** welcomed Alexander into their family in March to keep 6-year-old Ryan company. Ron is director of applied engineering development for Emhart Industries, headquartered in Connecticut. Ron coins the phrase "nerd metamorphosis" to describe a process a lot of us have gone through it seems: becoming more like real people and less like nerds as we grow out of our college days. . . . Nice letter from Fred and **Janet Stolz Sunness**: They've been in the Baltimore area for just over a year. She's doing her ophthalmology post-doc at the Wilmer Institute of Johns Hopkins Hospital. He's an emergency room physician, and they have two boys, Avram and Akiva. She says the kids are "thriving." . . . **Mitchell Aaron Fine** announces the birth of their fifth child. Mitchell is at Shearson Lehman/American Express as a financial consultant in New York City. . . . **Keith LaJoie** and his wife Ann announce their first child. Keith is now vice-president of the retail division of Polaris Enterprises Corp. He and Ann are building their own home in Northboro, Mass.

Eve Hollander has moved to St. Louis, Mo., where husband Irwin has a job with Monsanto. Eve is still a full-time mother-housewife-chauffeur. . . . Sharon and **Alan Horowitz** were expect-

ing their second child in June. Daniel just turned three. They're living in Silver Spring, Md.; Alan works as an attorney in the Office of the Solicitor General, U.S. Department of Justice. He mentions **Rhett Butler** in his letter. Rhett and spouse Kim Marie and offspring Marika are living in Honolulu, where he's doing geophysics research in conjunction with the University of Hawaii. . . . **Craig Presson** dropped me a long post-card, written in that small-but-perfectly-legible script a lot of us programmers call handwriting. First he "slipped out the back door of Building 2" with his Math degree. Then: The Computer Industry, working for Management Techniques, A.D.L. Systems, and now Data General where, after five years, Craig is a principal programmer in small operating systems. Kathy (nee Kupka) and he live in "scenic" Dedham with daughter Diana (3) and brand-new son Robert Craig. . . . In a commendable burst of optimism, **Shelly Cooper** writes that after having baby Benjamin last fall (and enjoying him "immensely"), she hopes to resume her wind-surfing efforts this summer.

Our class donated a ton of money to refurbish the weight room under the student center, turning it into the Class of 1974 Health and Fitness Center. Gone is the "sweat shop." In its place is a larger, cleaner, better ventilated, better lighted, supervised training center. The facility has been transformed, resulting in a significant increase in the purchase of athletic cards, especially by women. The original purchase of ten Nautilus machines was supplimented by the purchase of three more due to heavy usage. Under the coordination of Professor Jane Betts, assistant athletic director, the Class of 1974 Health and Fitness Center has become one of M.I.T.'s "most popular facilities," hosting more than 300 users a day in addition to Phys. Ed. classes. Says Professor Royce Flippin, director of athletics at M.I.T., "I hope your class knows, we can't be more grateful."

Matthew Kaufman writes that he's decided to leave the worlds of pure math and academia to do "something more useful." He's starting a new job with Burroughs in Austin, Texas. . . . Elizabeth Adams and **Raymond Van Houtle** are celebrating their second wedding anniversary. They just bought a house. He's writing software for multi-microprocessor systems for M/A-COM. . . . Recently appointed to junior partner at the law firm of Nutter, McClennen and Fish in Boston is **Laurence Reece**, and by the time you read this he'll be married to Debra Brustin a year. When Debra passes her bar exams, they'll be a two-lawyer family. . . . If two lawyers, then why not two physicians? **Peter** and **Brenda Chinn Kurnik** announce new daughter Julia Dawn, born October 27, 1983. Now older daughter Rebecca will have someone to play with. Peter and Brenda joined the faculty of the Washington University School of Medicine in July. . . . **Mark Goodrich** writes that he has recently taken over the duty of general manager at the E. McGrath Co. of Salem, Mass., suppliers of used equipmennt for the high tech industry.

Two notes from the Big Apple: **Arnold Phillips** recently went into private practice in Internal Medicine and Pulmonary Medicine. . . . **Larry Bowman** now works for Chase Manhattan Bank. . . . "Am enjoying doing a lot of travelling and visiting friends in the U.S. and Europe," says **Carl Howe**. He and another M.I.T. alumnus, Ward Harriman, built and flew a Vector 627SR ultralight airplane last summer. Carl's a systems engineer for B.B.N. Communications Corp. in Cambridge. . . . **David Humsey** has joined Advantage Systems, a new banking software company in Waltham, Mass., as director of client services. . . . **Charles Hillman** and family have moved from Silicon Valley back to Wisconsin to start a consulting firm in CAD/CAM. . . . By the time you read this, **Stephen Blythe** will be finishing his last year of family practice residency in Portland, Maine. . . . This note comes from FIJI brother **Ken Green**: "Still working for Exxon Research here in Baghdad-on-the-Bayou [Houston]," he writes. "My 2-year-old son is learning Texan and keeping me busy. Hope to see the FIJI's and other '74 classmates at the reunion." So did we, Ken. Where were you? . . . New class co-secretary **Rich Sternberg** is looking for news from you. Write him at 1800 Old Meadow Rd., McLean, VA 22102.—**Lionel Goulet**, 21 Melville Ave., Dorchester, MA 02124; **Jim Gokhale**, 45 Hillcrest St., Arlington, MA 02174

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A year ago, **Thomas McKim** married Jane Winans (Kenyon, '78) in Bedford, N.Y. Jane is the Washington office manager for Congressman Charles Schumer of New York. For their honeymoon they went backpacking for three weeks in the Grand Tetons in Wyoming. "It was short on luxury, but long on scenery!" . . . **Steven Ralston** writes, "After a European vacation last summer, we came back to find the perfect house in Roland Park. To keep in the state of total flux, in December, 1983, I left the Fidelity and Deposit Co. of Maryland and joined the First National Bank of Maryland as a senior trust investment officer. My duties are to follow the technology and capital goods industries and to recommend equity investments with above average potential to the Trust Division's portfolio managers and trust officers." . . . **David Murotake** is currently pursuing doctoral studies at the Sloan School in management of technology/management information systems. He is on a full-time sponsorship from R.C.A. Automated Systems, Burlington, Mass., where he is employed as a systems engineer/analyst in C^3I systems. . . . **Brian Lustbader** is an associate at the law firm of Rosenman Cohn Freund Lewis and Cohen in New York, N.Y. He married Rachel Ostow, an associate at Weil Gostshal and Manges, in 1978. Their first child, Sarah Pazit, was born on January 30, 1983. . . . Lieutenant Commander **Jeffrey Schweiger** graduated with distinction from the Naval Postgraduate School, Monterey, Calif., in October, 1982, with an M.S. in systems technology. He is currently assigned to the aircraft carrier *U.S.S. Ranger* (CV-61) as a combat information center and anti-submarine warfare module watch officer.

Daniel Jones has been working for Cal Recovery Systems in Richmond, Calif., since 1980. He recently returned from a 20-month assignment in the Philippines, where he served as a consultant to the U.S. Agency for International Development and the Asian Development Bank. His work there involved agricultural waste and municipal solid waste management. Currently he is doing some research and development on wood gasification. . . . **(Roy) Scott McKenzie** received a master's degree at the University of Massachusetts, Amherst, in 1978 (fisheries biology). He has been employed at Scott Laboratories, Inc., in Rhode Island, a medical device and diagnostics manufacturer. Presently he is the quality assurance manager. He married Alice Cassidy in August, 1982. ("Wonderful time," he comments.) He has been an educational counselor for M.I.T. since November, 1983. . . . After leaving M.I.T., says **Sanford Krasner**, "I spent three years at Draper Laboratories, then 'moved West, young man' to sunny Southern California (actually smoggy Pasadena). I'm currently cognizant engineer in charge of attitude control flight software for Project Galileo at NASA's Jet Propulsion Laboratory. That means I get blamed if it doesn't work. Southern California is quite a change from the Hub, but last winter made me think I might be in the right place." . . . **Roger White** and his wife Sue write that Roger's book, "Wordstar with Style," has done well, selling about 6,500 from the first printing (of 10,000) in only three months. The publisher, Reston, plans a second printing. The book also made #43 on Micromedia's list of top 50 computer books. Sue has finished school, getting a B.S. degree from the University of Utah; she has a personalized form letter business. They have completed an addition to their house, the need for which should be obvious when you consider that the residents include three daughters (Altair, Heather and Adrienne) one German shepherd (Sargon) and five cats (Fluffer, Heather-Kitty, Wabash, Midnight and Star). Roger's job is training supervisor for Beehive, makers of the Topper personal computer.

Richard Horwitz has been named assistant to the president of Polychrome Corp., a maker of equipment and supplies for the printing industry. He is also director of materials management. . . . **John Allen** was the translator for a book recently published by M.I.T. Press: "Spatial Hearing: The Psychophysics of Human Sound Localization," by Jens Blauert. . . . **Mark Hurwich** has become a principal in the consulting firm of Towers, Perrin, Forster and Crosby, located in New York. He is a specialist in general management services and compensation. . . . **Charles Tucker III** was the recipient of two major professional awards: a T.R.W. post-doctoral award and an N.S.E. Presidential Young Investigator award. He is an associate professor of mechanical and industrial engineering at the University of Illinois. The T.R.W. award involves spending a year doing research at a German or British University. . . . A Presidential Young Investigator Award was also given to **John Hollerbach**, assistant professor of psychology, control systems and robotics at M.I.T. . . . **Chris Flanigan** was awarded the Outstanding Young Engineer award by the San Diego chapter of the American Institute of Aeronautics and Astronautics. He is currently a project manager with Structural Dynamics Research Corporation in San Diego.

Kenneth Rumstay received a Ph.D. in astronomy from Ohio State University in June, 1983. He and his wife, Sue Ellen, were expecting their first child in May. . . . **George Herman** is still working for Digital Equipment Corp., but he moved from finance to business reporting and metrics for the Low End Business Center (personal computers). . . . **Roger Hale** was appointed vice president, Southern region, of A.T. and T. on March 1, 1983. . . . **Lawrence Moss** is a resident in psychiatry at the University of California, Los Angeles. . . . **Beth Karpf** graduated from Boalt Hall School of Law at the University of California, Berkeley, in May, 1983. "I had a delightful post-bar-exam excursion through the French and English countryside and am now practicing general business, corporate and securities law with Shartsis, Friese, and Ginsburg in San Francisco. M.I.T. alumnus Barry Sacks, '61, is a partner in the firm." . . . **Richard Withers** reports that "Linda gave birth to a healthy and beautiful baby girl, Stacy Lyn, in November, 1983. I am developing solid-state devices at Lincoln Laboratories. . . . **John Russell** was married to Marilyn Gail Lazenby of Petersburg, Va., on June 16, 1984.

Three notes from the wonderful world of software: **Sandra Lakin** says, "I am now working for a tiny software company writing computer games and having a wonderful time! Hubby Allan has moved into management in an aerospace materials firm. Our son, Paul, will probably be in the Class of 2003—if we avoid infanticide during the terrible twos." . . . **Jeffrey Moore** is president of his own computer consulting firm, with clients in New England, the West Coast and Europe. . . . **Jenny Glendinning** is a principal in a software consulting company. They have been in business just over a year and now have 20 employees. She is enjoying life in Boulder.

I regret to report the death on June 2, 1984, of our classmate **Roy Whitehead**. He was 32 years old. Together with a friend, Mark Chagnon, he founded a Nashua, N.H., research company called Renaissance Technologies; in 1981 the company became Advanced Magnetics. It developed Bio Mag, a magnetic separation technique used for medical diagnostic tests. In April, 1982, he was found to have cancer of the thyroid gland. Our condolences to his wife Jeni Fleming of Hingham, Mass., and two daughters Erin (5) and Meg (2).—**Alex Castaldo**, Secretary, 929 Mass Ave. (12D), Cambridge, MA 02139

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From **Joe Tavormina:** "Manager, Radar Cross Section Product Development, Scientific-Atlanta Division." . . . **Bill Menke** writes: "Recently authored graduate level textbook, *Geophysical Data Analysis* (Academic Press, 1984)." . . . **Melissa Weiksnar** sends word that she is having great fun at Apollo Computer managing their manufacturing prototype lab for their new mid-range color product. It doesn't leave enough time for her gardening, though. She enjoyed a two-week trip to Japan last September, where she toured Matsushita and Japanese gardens. She warns, "Admitting to one's host that one is adventurous may result in a live squid at the dinner table, and not just for decoration!"

Jeslie Chermak writes that he took a two-month vacation from HP to see Europe with a Eurail Pass and a Youth Hostel card. He reports, "Fantastic! Came back and did some thinking. Now work for Rolm. What a rec center! Wonder how many folks change jobs after a long vacation!"

Diana Dickinson sends an update: "Since you last reported on me (1981), I have ceased to work for Reuben Engineering Corp. (which, alas filed for bankruptcy before the notes were ever published); worked briefly for Computervision Corp. (before leaving because of boredom with my job); and worked for Raster Technologies, Inc., a now established, then start-up computer graphics manufacturing company. I left Raster in January to work for myself as a free-lance marketing writer (mostly writing technical articles on various aspects of computer technology); I also married John G. Torborg, Jr. (Rensselaer, '79) in January. I am greatly enjoying the personal and financial rewards of self-employment, especially the flexibility to spend good days gardening and cold wet days working."

An amazing postcard from **Dan Seligson:** "I successfully climbed Mt. McKinley by way of its Northwest Buttress in a 23-day expedition in May. It was quite warm, only -30° F at night, and I got frostbite on only five fingers. Needless to say, it was a party! Then, with a partner from down under, I climbed the Moose's Tooth, the Alaska Range's most beautiful peak. To cap off six weeks on ice, a guide from Outward Bound and I tried an obscure route on Mt. Barille, but we were forced to turn back by snow up to our chests and an avalanche that almost killed us. . . . Now I must go to work to support this habit, climbing, so I will put this degree of mine (University of California, Berkeley, Ph.D., physics, '83) to some rewarding use. Say hello to the whole sick crews from Crafts."

As for your secretary, he had the pleasure of bumping into **Erland van Lidth de Jeude** on Broadway before these notes were due. He has been on a special diet program and looks terrific, thinner now than when we first met as freshmen. As for show business, he recently made two TV commercials—hopefully, by the time these notes are published, they will have been aired. On the second accidental meeting on Broadway, we also were with Sue Morgello, '78, who with Erland, was taking jazz dance classes near here.

As for the market, the U.S. dollar, as of this writing is at or near record levels against the currencies. Your secretary believes that this will be the top for the dollar this year—a brave statement. Cocoa also has been whizzing around, as has of course the Bonds, gold, silver, and palladium. It continues to be an amazing, frightening time for people in the futures business, both in terms of trading and advising people. From my perspective, a lot of people, myself included, are both worried and scared of and for the fragile international financial system. One can smell the fear over the telephone, especially from Europe.

On a cheerier note, by the time this is published, Rita and I will hopefully be moving into our new home in Forest Hills, N.Y. You may have heard of the place!—**Arthur J. Carp,** Secretary, 211 W 79 St., Apt. 5, New York, NY 10024, (212)362-2450

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Charles "Chip" Moss, who has been in Israel since June, 1982, married Penina Hershkowitz, originally from New York City. Chip is now directing an Israeli branch of an American consulting and seminar development company. . . . **Peter Van Doren** is completing his doctorate at Yale, and will be teaching domestic public policy in the fall as an assistant professor at the Woodrow Wilson School of Public Affairs at Princeton. . . . **Steven Bader** recently married Angela Macchiarulo. Stephen manages a dental group practice in Burlington, Mass.; Angela is completing her pediatrics residency at Children's Hospital. . . . **Janice Izenberg** has recently joined Swanre Hayden Connell Architects in Washington, D.C. Janice is enjoying her work and Washington's urban life.

Steven J. Grossman married in November, 1982, and moved to Silicon Valley, where he is memory product marketing manager at EXEL Microelectronics. EXEL is a startup making EEProms and CMOS chips. Steven is enjoying California and hopes to get rich on the stock! . . . **Fred Rust** sends a nice note describing life since graduation. Fred worked in data processing in New York, N.Y., and married Beth Cancain, from Boston. Last year, Fred and Beth moved to Salt Lake City, where he worked as a data management consultant for American Express. Fred and Beth are moving to Cambridge this fall, so that he can begin working on his M.B.A. at Harvard. Fred hopes to see some PKTers now that he's back in New England. . . . **Craig Johnston** enjoys his work at the National Institute of Environmental Health Sciences. His wife, Sharon, works at Duke Medical Hospital, and they have a daughter, Hope, who is 3 years old.

Let me take this opportunity to editorialize a bit. When you send in your notes to M.I.T. on an Alumni Fund form, the "notes on my activities section" is usually separated from the rest of the form. This means that your current address, full name, and other vital statistics go to Alumni Fund headquarters, not to your class secretary. Often, I get requests for current addresses from classmates, but can't help. Also, when you get married and have children, please share the names of your new family. And if your handwriting is not too legible, please be tolerant of my misspellings and mistakes. Keep those cards and letters coming—I'm sure you look forward to seeing notes about your friends in this column, but don't forget they'd like to read about *you*.—**Barbara Wilson Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

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Greetings from an alternately sunny and rainy summer in Boston. I've got a pile of news for the hungry gossip fiends among you. . . . **Alice Cowan Campbell** has had quite a busy year or so. She got married last September to John C.W. Campbell. Shortly after the wedding, Alice and John bought an older house in St. Paul, Minn., "joining the ranks of homeowners in the class." Then, Alice decided to undertake a major career change—she left the ranks of "research food engineering" and became a banker with the Commercial Lending Program at First Bank Minneapolis. Alice and John are still active members of the Minneapolis Rowing Club. They invite all the rowers out there to their Head of the Mississippi on October 6. . . . Two other tidbits from Alice: **JoAnn Politano**, who was in Alice's wedding party, is working for Beddis Labs in Pittsburgh as a senior metalurgical engineer. . . . **Sue Frank Dechant** graduated from Boston University Law School and will soon begin practicing law.

George Drakeley is now a lieutenant in the navy currently serving as senior nuclear officer on the trawler *U.S.S. Acadia;* his responsibilities include supervising repair work. Previously, George was electrical officer on the *U.S.S. Arkansas* and supervised shock testing nuclear ships. **David Yang** recently commissioned into the Air Force as a second lieutenant. David is assigned to Tyndall AFB in Florida. . . . **Sheila Luster** writes that she is still living in Tucson, working as a construction project coordinator for Esconi Builders. Sheila is still playing volleyball, tennis, and soccer. . . . **Linda Lampron** gets to wear a hardhat at her new job—as an engineer on a field construction project in Connecticut. Previously, Linda had done a variety of tasks with Werner Erhard and Associates, working on subjects including "common security and the question of nuclear war."

Mitch Weitz couldn't take it any more—my "heart-rending pleas for news," that is. So he decided to write in. After graduation, Mitch started in a Ph.D. program in chemistry at Harvard. But, says he, "after a while, I realized that chemistry and I really did not share a long-term future (translation: chemistry sucks). So after spending a total of three years there, picking up a master's degree along the way, I entered Harvard Law School." This month Mitch will join the litigation department of New York City's Paul, Weiss, Rifkind, Wharton, and Garrison. . . . And, another lawyer, **Don Lampe** was recently transferred to the London office of his law firm Akin, Gump, Strauss, Hauer, and Feld of Dallas. In London Don will be "handling international banking and business transactions as well as representing European investors in the U.S."

Now from lawyers to doctors. **David Levens**—ahem, Doctor David Levens—wrote me a note from the Bronx, where he is going into his third year in a general surgery residency at Albert Einstein/Montefiore Hospital Medical Center. After that, in 1986 David will specialize in plastic surgery. This February, David married Simmons grad Linda Keyes "at a black tie wedding in the Doral Hotel, Miami Beach." Linda works in the communications department of CBS Sports.

A press release from the *Berkshire Courier* from Great Barrington, Mass., announces that **Barry Linder** has just graduated from the medical school of Washington University of St. Louis. (Barry also has his master's in biomedical engineering.) He'll be starting his internship at St. Luke's Hospital in St. Louis and will then have a research fellowship in ophthalmology at Washington University. . . . **Lucy Everett** jotted a quick note to remind us that she is a resident at the Medical College of Virginia. . . . **Michael Nathan** just entered the third year of med school at Rush Medical College in Chicago and is starting clinical work. Mike says he has settled into Chicago somewhat but still misses the ocean and New England's personality. . . . Dr. **Julie Keller** sends a bizarre (but not boring) postcard from her home town, Burlington, Vt. But Julie will soon be leaving scenic Burlington to move to New Jersey, of all places. She writes, "Now, why in the world would I *ever* consider NJ??!!! Well, I'm going there to join my fiance, David Pease, who works for Prudential Insurance. We're getting married September 8 on Swans' Island, Maine, near Acadia National Park." Ah, young doctors in love.

I recently got a surprise phone call from **Gail Heffner Kahn** and **David Kahn**, inviting me to dinner with **Penny Friedman**, who was visiting Boston from D.C. Penny is working for a small prestigious D.C. consulting firm doing work for the Department of Energy. David is working for Wang in Lowell, Mass. managing the marketing of special informations systems. Gail is taking some time off from work to begin raising Jennifer Maryn Kahn, born June 18 of this year. . . . And speaking of births, **Paul O'Brien** asked me to announce the birth of his son, John Paul O'Brien on March 27, 1984. (He was delivered by Dr. Steven Warsof, '73.) Daddy O'Brien has finished his graduate work at Minnesota and is now an economist with the Federal Reserve system "keeping a close eye on the money supply."

Now from the sublime to the ridiculous. Yet another note from **Dick Field**: "I'm no longer a dim-wit at Computervision in Bedford, Mass. Now I'm a full-time software entomologist. I see Limp ('76) but where's Garvin? Blome to Nino (Pedrelli) Hy-Jeanne! Any lobsters at NRSA?"

And last and least, me, your class gossip. At last I have some real news. In the past six months, both my wife (Yuko Takagi) and I have changed jobs. Yuko is working for Wang in Tewksbury, Mass. handling product distribution for the Far East. And I have (temporarily?) left the practice of law to work as a senior auditor for Blue Cross of Massachusetts. I work as part of a team administering the most controversial part of Blue Cross' contract with hospitals—that is, whenever a hospital wants more money they come to us. It sounds dull, but it really is the very heart of the hospital reimbursement system in Massachusetts. After six weeks, I love it. Do I miss practicing law? Not really—I expect to have to argue with more hospital lawyers at my new job than I did at my old. And, believe it or not, it's kind of refreshing to have to deal with numbers again.

I guess I'm weird. But whatever I am, I'm still your class secretary. *So send me news!!!!*—**David S. Browne**, 50 Follen St., 104, Cambridge, MA 02183, (617) 491-5313

79

Greetings, classmates. Here's the roving reporter to fill you in on our five-year reunion, June 9-12. As you have guessed by now, I was reelected to the office of secretary/treasurer for another five years (lucky you!). Here are the rest of our new officers: president, **Brenda Hambleton**, who was previously our class agent and who did a wonderful job organizing the reunion; vice-president, **Bruce Bornstein**, formerly member-at-large; members-at-large, **Bill Rust**, **Bonnie Mason**, and **Lisa Bendixen**; class agent, **Rick Kovalcik**, who ran the recent M.I.T. alumni fund telethon in Cambridge.

Some good news: as a reunion gift, we raised $27,000 for the Class of '29 Scholarship Fund. Any contribution from a '79 class member that was at least $25 more than last year's gift got matched by the Class of '29. On behalf of the class, many thanks to those of you who donated money for this cause. Now, on to the gossip!

Lisa Bendixen spent an extra year at M.I.T. getting her master's degree in operations research and is now employed as a consultant by Arthur D. Little. Lisa and husband Jon Leehey, '78, own a condo in Malden, Mass. . . . **Martin Black** is working on a Ph.D. in astrophysics at the University of Maryland, located in College Park, a suburb of D.C. Martin hopes to be finished in another year or two.

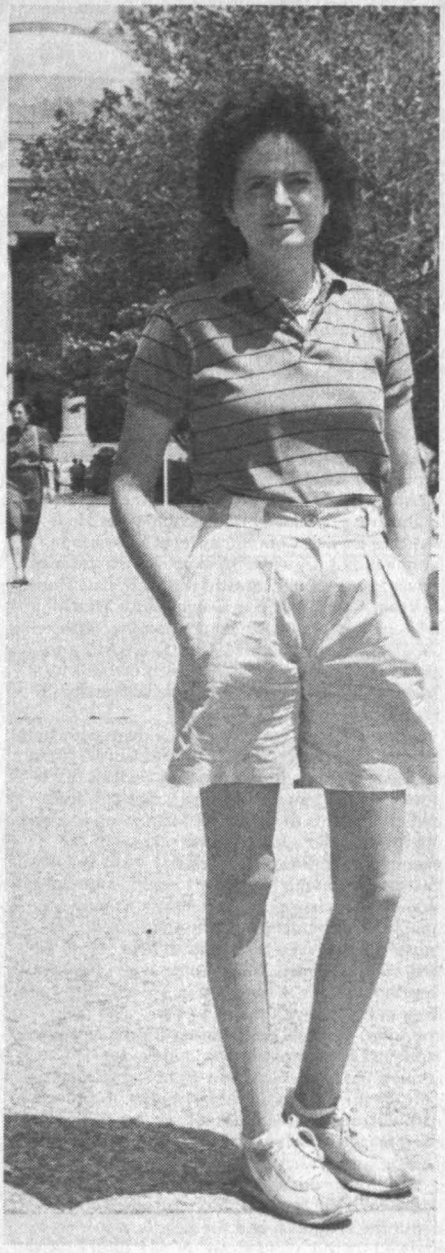
Jeff Bloch is getting his Ph.D. in physics from the University of Wisconsin at Madison in the field of x-ray astronomy. Jeff just passed his preliminary exams (yay!), and recently participated in the launch of a sounding rocket in White Sands, N.M. . . . **Bruce Bornstein**, our new vice-president, graduated Tufts Medical School in 1983 and just finished his internship at Mt. Auburn Hospital. He's now doing his residency in radiation oncology at the Harvard Joint Center for Radiation Therapy in Newtonville, Mass. On June 24 of this year, Bruce married Wendy Stearns (University of Massachusetts '80), an accountant, who was with him at the reunion. . . . **Bob Briselli** is still with DuPont and still plays bridge! Bob lives in Southfield, Michigan, with his wife of two years, Cathy Marchand, who is a chemist with DuPont.

Sue Burzyk was at the reunion but was mentioned recently in *Tech Review*. . . . **Martha Choroszy-Marshall** is a project manager at Thermal Systems, Inc., in Woburn, Mass., doing R&D in combustion of industrial heating processing. Martha and Mark Marshall, '80, were married in March of this year. . . . **Dorothy Comeau** is a grad student in molecular biology at SUNY Stony Brook. Husband Jed Fuhrman, '77, is a professor there in oceanography. . . . **Ben Cooper** is a lieutenant in the navy, currently a project officer for Naval Nuclear Matters. Ben works in Crystal City, Va., and walks to work from his home in Northern Virginia. . . . **Jeff Dugal** is a mechanical engineer in processing development for Rampart Packaging (manufacturers of multilayer plastic containers for food packaging) in Williamsburg, Va. He is also taking M.B.A. courses at night at William and Mary College.

Marla Eglowstein is living in Brooklyn Heights, here in New York, but ran out before I could talk to her (what nerve!). . . . **Arlyn Garcia Perez** just finished her Ph.D. in biochemistry at Michigan State University in June, and is now at the NIH in D.C. doing a postdoc. Arlyn was accompanied at the reunion by her sister Evelyn Garcia, '76. . . . **Sharon Gardner** lives and works in Salem, Mass., where she is sales manager for Small Business Systems, Inc. She will give a discount to any class members in the area. Sharon's husband, T.J. Jacobs, '75, works for New England Telephone. . . . **Norm Guivens** has left the navy and will be starting work in September 1984, in a ministry-related position for the Catholic Diocese of Raleigh in North Carolina. He planned to spend the summer vacationing, including a six-week seminar in philosophy at St. Meinrad's Archabbey in Indiana. . . . **Brenda Hambleton** is at the Sloan School full time getting a master's degree in marketing. She'll be finished next June. She's also working half time at the M.I.T. Admissions Office. Brenda's husband, **John Hopper**, is a mechanical engineer for Northern Research, a subsidiary of Ingersoll Rand. He's now writing and packaging software for automated systems. . . . **Ed Hunter**, and **Chuck Keilers**, both mentioned recently in *Tech Review*, were at the reunion.

Rick Kovalcik is working for Honeywell in Kendall Square in computer networking development. He bought a condo last year near the Chestnut Hill Reservoir. . . . **Bonnie Mason** lives in Melrose, Mass. and works for Wang as a business analyst in the manufacturing area. Bonnie and Al Chock, '78, were married last year. . . . **Mark Matson**, at reunion time, was about to get his Ph.D. from M.I.T. in electrical engineering. . . . **Ron Newman** is still in Santa Monica, Calif., working for Xerox. He planned a six-week bicycling vacation in Europe this past summer. Ron is secretary of the Los Angeles Chapter of Computer Professionals for Social Responsibility. . . . **Karl Nyberg** got his master's in electrical engineering in 1981 via the Co-op program. He spent a year in upstate New York doing research, and now works for Verdix Corp. in MacLean, Va., writing proposals. They're one of those companies that builds computer systems for the U.S. government. Karl owns a house in Vienna, Va. . . . **Todd Peltzer** is in the navy, stationed in Pearl Harbor, Hawaii, for the last two years. He is a diving and salvage officer on a squadron staff. He is also developing microcomputer applications for salvage ships. Todd owns a house in Kaneohe.

Rob Phipps is a technical manager for SEI Corp., which builds systems for financial institutions. He is currently working on electronic funds transfer. Rob lives in Maynard, Mass., with his wife of four years, Dorothy, and their 2-year-old son James. . . . **Dixie (Kaufman) Paulos** and **John Paulos** got married on July 28, 1979. Dixie got her master's of architecture from M.I.T. in 1982, and at press time was writing software for architects at Energyworks in Watertown, Mass. John was finishing his Ph.D. in electrical engineering from M.I.T. this past summer. They were planning a move to Raleigh, N.C., where John will be an assistant professor in electrical engineering at North Carolina State. . . . **Bill Rust** just moved back to the Boston area (Billerica, to be exact) from Omaha. He works for a small consulting firm called Transportation Systems. Also working there is **Bengt Muten**. Bill and wife of six years,



Joanne Tobias, '79, represents the most recent reunion class returning to M.I.T. in June. Tobias is practicing general dentistry with her father in Elmwood Park, N.J. (Photo: Frank Revi, '86)

Marcilyn, have a 2-year-old daughter, Shannon. . . . **Fran Savoia** lives in Arlington, Mass., and has been working for the last year as a production process engineer in the pharmaceutical filters area of Millipore Corp. in Bedford.

Joan Sienkiewicz is a senior engineer with Electric Boat in Groton, Conn. Joan has been splitting her time lately between Groton and D.C. On recent trips to D.C. she has seen **Paul Denney** (who works for Naval Research Labs) and **Cindy Cole**. At the reunion roller skating event, Joan delighted us all with her expert figure skating. . . . **Martha (Williams) Schaefer** got her Ph.D. in planetary science from M.I.T. in September 1983. She is now doing a postdoc in the Geophysical Lab at the Carnegie Institute in D.C. Martha and Brad Schaefer, '78, were married in 1979. . . . **Joanne Tobias** received her doctorate in dentistry in May 1983 from Boston University. She is currently practicing general dentistry with her father in Elmwood Park, N.J. and living in nearby Fair Lawn. . . . **Patrice Tyrell** is getting her Ph.D. in chemistry from Yale this year. . . . **Meredith Warshaw** planned to start Brandeis in September for a Ph.D. in psychology. . . . **Andy Weiner** got his Sc.D. from M.I.T. in electrical engineering (lasers) in June of this year. He is working for Bell Communications Research in Holmdel, N.J. . . . **Joel West** spent two years as a newspaper reporter, mostly with the Vista Press in Vista, Calif., near San Diego. Since March 1983, he has been a senior programmer with CACI, programming SIMSCRIPT, a CACS programming language. Joel has been married for one year to Lori, a student at the University of San Diego.

Brian Wibecan got his master's degree in choral conducting from the New England Conservatory but decided to go into computers instead. He is now a programmer analyst for Computer Information Systems in Braintree, Mass., and is working for a master's in computer science in the evenings from Boston University. Brian lives in Eastgate with wife Nancy Levoy, '81, a graduate student in archaelogical metallurgy. Nancy was unable to accompany Brian to the reunion because she was on a three-month field trip to Ecuador. . . . **Thomas Wong** is manager of software development for Wang Labs in Lowell, Mass. He lives in Boston with his wife, May, who is an accountant. . . . **Bill York** was a programmer for Honeywell in Cambridge, but moved to D.C. about a year ago. He's now technical sales support for the D.C. office of Symbolics, a computer manufacturer that is an M.I.T. spinoff. He has been married for two years to attorney Shawn Lampron (Harvard '79).

Well, those are all the people that I got to speak to at the reunion. More info next time about the activities, and the people who either showed up but avoided me, or else didn't show up at all but have friends with loose tongues! Please note the change of address.—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

81

This month brings news of several of our classmates' academic pursuits. **John Wenn** writes, "After three years of working in the 'real world,' I'm returning to Carnegie-Mellon for my Ph.D. in computer science. (P.S. Hello to all student house members, former and current.)" . . . **Eric Bartlesman** is working on a Ph.D. at Columbia. . . . **Bob Wildrin** is finishing his third year at the University of California at San Francisco Medical School. Bob writes that he occasionally runs into **Nevels Scott** and Tim Jones, '78, there. Bob has also visited fellow '81ers: **Claudia Buser, Amy Luttiner,** and **John Keklak**. Bob asks any friends visiting San Francisco to look him up.

On the corporate side of things, **John Delfield** reports that after just receiving his master's from Sloan, he has accepted a marketing management position with NCR in Dayton, Ohio. . . . **Bert Wallach** and Mark McMiller, '82, have left TRW to found their own company, Advancing Processing, in San Diego. The new company's areas of business include signal processing and data processing systems design. They welcome inquiries. . . . Finally, **James Oker** is "taking pictures, riding a bicycle, and making interactive video discs."

I write this column surrounded by the green mountains of western North Carolina. Although this won't appear till October, it's currently July at Falling Creek summer camp. The sailing is good, but the little kids are beginning to get to me. Keep those cards and letters coming!—**Chuck Markham,** Secretary, Box 54, M.I.T. Branch, Cambridge, MA 02139

82

Hello classmates. **Rich Segal**, associate secretary, sent plenty of news this month. . . . **Ed Rosenweig** is working on Wall Street for the U.S. Trust Co. And, as Rich says, since Ed's noontime meal is provided gratis, he's laid to rest the economic theory that there is no such thing as a free lunch. . . . **David Copeland** has finished graduate work at Stanford. He's turned down an opportunity to teach English in Japan, preferring (in Rich's words) to "find a position with the liberal Eastern establishment." Otherwise, David may give business school a try. . . . **Alison Kutchins** and **Billy Winokor** are working in the Wall Street area as well. . . . Rich says, "**Mark Hartney** is working at Bell Labs in New Jersey of all embarassing places." Mark reports that due to the large proportion of engineers at Bell Labs, he dresses really well by comparison.

Robert Sah was named a Metropolitan Life fellow. He's now in the Harvard-M.I.T. Health Sciences and Technology Program working toward and M.D./Ph.D. in medical engineering and medical physics. Congratulations, Bob! . . . **Peter Balbus** writes that he's in Washington, D.C. working for Network Strategies, Inc., an engineering and management consulting firm specializing in voice and computer communications networks. . . . **Rhonda Peck** passed the third actuarial exam in the series of ten; her cat had kittens; and she's started taking piano lessons after a leave of almost seven years from the keyboard. . . . Write soon!—**Rich Segal**, Associate Secretary, 83 State St., Brooklyn Heights, New York, NY 11201; **Rhonda Peck**, Secretary, 38 Bigelow St., Cambridge, MA 02139

84

Hi folks! I hope y'all are in good health. Since I am writing this column in July, I have yet to see my first column in print, and haven't gotten any feedback on it. However, I'm so sure everyone really enjoyed my writing style that I'll continue (for the time being at least) in the same abrasive style. My last column featured chemical engineers and marriages (and permutations thereof). This issue brings you more of the same plus news about classmates staying in the Boston area this summer.

We begin by announcing more marriages. **Daphne Clark** and Joel Gould, '83, were married on June 2. . . . **Mary Ann Fisher** and John Erickson, '81 married on June 30, and will settle in the Boston area. . . . **Ahsen Iqbal** and **Linda Siemer** will hold their wedding on September 16; they then plan to move to scenic Pontiac, Mich., where Ahsen will work for GM. Even though I was not invited to any of these weddings (OK, I did attend John's bachelor party), I extend my best wishes for a happy future to each of these couples.

Recently, I ran into **Mark Tarpinian**, who is still an eligible bachelor, and mentioned that he was named in my first column. It seems that there are several points I should clarify: Mark will be working for Advanced Microsystems in Sunnyvale, Calif., and does *not* plan to give up tennis. . . . I spotted **Steve Dubnik** early one morning this summer. I yelled out to him, "Dubbie, whatcha up to?" "I'm late for work," he yelled back. "Where?" I inquired loudly. "At the REACTOR," Steve exclaimed as he hurriedly disappeared down the street. . . . I had a slightly longer conversation with **Steve Barber**, former SCEP chairman and a very important guy. Mr. Barber informed me that he was "finishing up" his thesis, and intends to work subsequently for Rabbit, a small software firm in Valley Forge, Pa. When I asked him for what reason would a company name itself "Rabbit," Mr. Barber replied, "Sheer randomness."

I also exchanged pleasantries (and gossip) with **Annette Hulse**, who is working as a research assistant for Temple, Barker, and Sloan, a management consulting firm in Lexington. . . . I spoke at length with **Luna Ho** who briefed me as to the whereabouts of the McCormick crowd: **Pearl Yew** will be working for Prime Computer. . . . **Hau Yee Ng** will be working for Xerox. . . . **Tina Bahadori** will be working toward her Ph.D. in chemical engineering at Yale. . . . **Wendy Lin** will be attending Chemical Engineering Practice School at the 'Tute. . . . **Jane Lee** will be working for Polaroid in Cambridge. . . . And **Elaine Lee**, who was named this year's top engineering student (with a 5.0 GPA), elected to return to dear, old Camp Cambridge for graduate school in electrical engineering. In trying to remember all this information, I forgot what Luna was doing; I do know, however, that during the summer she was working in the Longwood Medical Area in Boston.

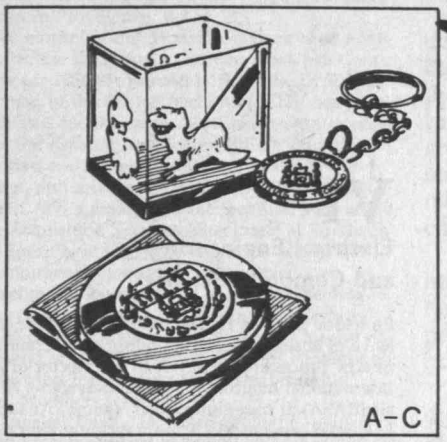
I have been informed that **Andy Chien** has been awarded the Burroughs Corp. graduate fellowship for study in electrical engineering. Andy was too modest to tell me this or even that he will be attending M.I.T., studying communications and control and planning to eventually pursue a career in teaching and research at the university level. . . . **Vickie Rodak** was working for Aspen in Cambridge for the summer and will be attending Chemical Engineering Practice School at M.I.T. in the fall. **Pam "Spam" Gannon** is "hanging out" for a year (by working at Boston University Hospital) and plans to return to school. . . . **Janet Pesaturo** and Robert Zak, '85, made dinner for me the other day. Janet is UROPing this summer and will attend SUNY, Albany Medical School in the fall. By the way, I would not object too strongly if other members of the class prepared meals for me also (or invited me out to dinner).

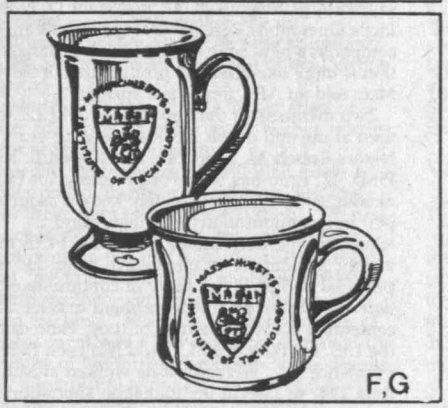
Recently, I saw two fellow chemical engineers, **Chris Panagakos** and **Dave Berkowitz**, appearing very relaxed and carefree. They claim to be "working" for Genzymes, a small biotechnology firm for the summer, yet they had enough free time to play softball on a weekday afternoon. . . . **Marie Macaisa** will be working for BBN after she returns from Paris. . . . **Heni Meerman** also spent his summer in Europe; when he returns, he'll work for Goodyear in Texas. . . . **Cecilia Tsai**, I, and a large group of friends went out for a going-away dinner for Cecilia. We celebrated her new condo, her new car (a Corolla), and her new job (IBM in Burlington, Vt.).

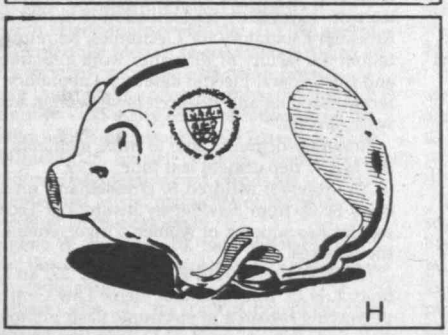
I have recently been informed that it is class secretary's duty to announce deaths. I am saddened to have to report the deaths of two of our classmates, **Jon Bucsela** and **Keith Ennis**. Jon, a math major, died from a congenital heart defect on April 3. Keith, whose death was an accident involving nitrous oxide, was pronounced dead at Massachusetts General Hospital on February 29 about 30 minutes after being found unconscious by two of his fraternity brothers at TEP. They were both awarded their degrees posthumously last June.

I still do not know my fall address, but I am sure that my mail will be forwarded from my summer address. I look forward to hearing from you. In the meanwhile, take care of yourselves and enjoy life.—**Peter Tu**, Secretary, 410 Memorial Dr., Cambridge, MA 02139

M.I.T. Insignia







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I

Civil Engineering

Two members of the department at M.I.T. were promoted to the rank of associate professor during the summer: **Amr S. Azzouz,** Sc.D.'78, a geotechnical engineer whose work in the Constructed Facilities Section of the department has included the stability of earth structures, tunneling, *in situ* tests, and the behavior of offshore piles; and **Clifford M. Winston,** an economist whose major research has been in economics applied to transportation and engineering systems.

II

Mechanical Engineering

Two members of the department at M.I.T. were promoted to the rank of associate professor during the summer: **Lallit Anand,** a specialist in the mechanics of large strain deformation of materials who joined the faculty in 1982 from U.S. Steel; and **Bruce M. Kramer,** '71, a leader in the Laboratory for Manufacturing and Productivity where he is a specialist in machining research and tool wear.

Within a decade, says **Ralph G. Colello,** S.M.'66, who is a member of the automotive group at Arthur D. Little, Inc., U.S. automakers will be heavily dependent on overseas sources for engine-related components and even for fully assembled engines for U.S.-assembled cars. Another reason, Colello told an ADL forum last spring, for automakers to adopt a world view.

Philippe Villers, S.M.'60, president of Automatix, Inc., received an honorary L.H.D. from Lowell (Mass.) University at commencement exercises last June, recognizing his leadership as a human rights advocate.

III

Materials Science and Engineering

Professor **Robert E. Ogilvie,** Sc.D.'55, who's been associated with the department since he entered as a graduate student in 1952, retired at the end of the 1983-84 academic year. Professor Ogilvie's research and teaching have centered on the use of x-ray diffraction in physical metallurgy, a field to which he has made a number of major contributions. He is also known for his use of related techniques for determining the character and authenticity of art objects, working chiefly in association with the Museum of Fine Arts, Boston. Professor Ogilvie came to M.I.T. from the University of Washington, where he did undergraduate work; he attained the rank of full professor in 1966.

A new agreement for comprehensive research on prehistoric metallurgy in Ecuador has been reached between M.I.T.'s Center for Materials Research in Archaeology and Ethnology and the Banco Central del Ecuador. CMRAE will perform technical analysis of many artifacts and will have a major part in training Ecuadorian museum personnel in studying and handling materials relating to the ancient metal industry. Professor **Heather Lechtman** calls the agreement "a model of the way research among colleagues in the Americas may be organized and conducted."

IV

Architecture

Oleg Grabar, Harvard's Aga Khan Professor of Islamic Art and Architecture, made headlines last spring when he told Colin Campbell of the *New York Times* that, though the Aga Khan Program in Islamic Architecture "has planted some seeds, the tree is not growing. We have not made the splash that was expected," said Grabar. But **Stanford Anderson,** who heads the M.I.T. Architecture Department's work in architectural history, theory, and criticism, took exception to that judgment: Saudi architects now pay more attention than before to "traditional architectural values," he says—and that's consistent with the Aga Khan's goals in establishing the ambitious program five years ago.

Professor **Horacio Caminos,** who has dedicated much of his professional work as well as his teaching at M.I.T. to the planning and design of urban settlements in developing countries, retired at the end of the 1983-84 academic year. He'll continue his architectural practice and his work on settlements for the poor in the developing world. A native of Argentina, Caminos studied architecture at the University of Buenos Aires before coming to the U.S. in 1940, then returned to Argentina to teach and work for 10 years. Finally in 1952 he returned to the U.S., first at North Carolina State College and in 1961 at M.I.T.

The American premiere of "Icarus," a sky opera by **Paul Earls,** fellow in the Center for Advanced Visual Studies, played in Kresge Auditorium to rave reviews late last spring. "An altogether dazzling theater experience," wrote Richard Buell in the *Boston Globe*. "An evening . . . filled with visual marvels," said the *New Yorker*. Only Tim Page in the *New York Times* was skeptical: "There was more than a little bit of Barnum to this entire undertaking," he wrote—"an unrelenting business that was often distracting."

V

Chemistry

The success of powerful portable, personal computers—the so-called "knee-tops"—is creating a technological crunch: large-area, flat-panel electronic displays based on liquid crystals, electroluminescence, and plasma are in short supply. A big challenge for chemists: to meet the demand estimated at $4.5 billion by 1992, panel prototypes must be developed within the next 12 to 18 months, says **Charles M. Apt,** Ph.D.'52, of Arthur D. Little, Inc.

VI

Electrical Engineering and Computer Science

Professor **Thomas H. Lee** has begun a three-year leave of absence from the Philip Sporn Chair in Energy Processing at M.I.T. to be director of the International Institute for Applied Systems Analysis (IIASA) at Laxenburg, near Vienna, Austria. Lee, who came to M.I.T. only recently after a long association with General Electric, has served as director of the Laboratory for Electromagnetic and Electronic Systems, and he was for a period associate director of the Energy Laboratory.

Four members of the department at M.I.T. have been promoted to the rank of associate professor: **Charles E. Leiserson,** a leading theoretical computer scientist; **Bernard C. Levy,** a specialist in systems theory and control; **Tomas Lozano-Perez,** '73, an expert in robotics; and **John L. Wyatt, Jr.,** '68, whose interests are in nonlinear circuits and systems, analog behavior of digital circuits, and the thermodynamics of electrical noise.

Deregulation of the U.S. freight industry has turned traffic managers into "logistics managers," says **Peter J. Metz,** S.M.'67, of Arthur D. Little Inc.'s Operations Research Section. In the highly competitive new environment, buying transportation is more like buying a product than a service, Metz told an ADL forum last spring.

Two members of the department at M.I.T. retired at the end of the 1983-84 academic year: Professors **Robert M. Fano,** '41, and **Robert L. Kyhl,** Ph.D.'47. Fano has been Ford Professor of Engineering since 1962; he's widely known as an expert in communications technology and telecommunications policy and in the 1950s made major contributions in microwave radar. He was a principal author of the study of continuing education undertaken by the department to celebrate its centennial in 1982. A native of Italy, Fano came to the U.S. to study at M.I.T. and has been here ever since. . . . Professor Kyle worked at M.I.T. from 1941 to 1948 in the Radiation Laboratory and later the Laboratory for Insulation Research and Research Laboratory for Electronics; he returned to join the faculty in 1956 after work at Stanford and the General Electric Research Laboratory; his recent teaching and research have been in microwave circuits.

Honorary degrees came to three members of the M.I.T. department last June:

☐ To Professor **Mildred S. Dresselhaus,** an honorary Sc.D. from New Jersey Institute of Technology for her support of women's involvement in the sciences.

☐ To Professor **Harold E. Edgerton,** '27, an honorary L.H.D. from Franklin Pierce Law Center for pioneering research in electronic flash photography; and an honorary L.H.D. from the University of Lowell (Mass.) for contributions to education.

☐ To Professor **Joseph Weizenbaum,** an honorary Sc.D. from Adelphi University for "outstanding achievements in computer science, and especially your elucidation of the impact of technology on human self-understanding . . ."

Professor **Patrick H. Winston,** Ph.D. '70, di-

rector of M.I.T.'s Artificial Intelligence Laboratory, has recently completed the second edition of *Artificial Intelligence* (Addison-Wesley Publishing Co.). The text explains the basic theoretical concepts of artificial intelligence and introduces representative application-oriented ideas. . . .

Associate Professor **Michael Hammer,** in the department at M.I.T., gave the keynote address, "The Changing World—Automation" at the Johnson and Walles College Advisory Council Plenary Session in Providence, R.I.

Two alumni of the department have been nominated to the IEEE Boston Section Executive Committee for 1984-85: **Ronald E. Scott,** Sc.D.'50, vice-chairman of the Boston Section of IEEE, has been nominated for chairman. Scott has served as editor of the *Reflector* (the Boston IEEE's journal), chairman and secretary-treasurer of the Boston Section, and a fellow of IEEE. And **Duane Matthiesen,** '69, a member of the technical staff of the Data Acquisition Systems Directorate at Raytheon Co., Equipment Division, Wayland, Mass., has been nominated for secretary/treasurer.

Celebrating its centennial at a major meeting in Boston late last spring, the Institute of Electrical and Electronics Engineers—the world's largest engineering or scientific society—put its spotlight on an Electrical Engineering Centennial Hall of Fame. Members from M.I.T.:

☐ **Vannevar Bush,** '16, former dean of engineering and vice-president of M.I.T., described by IEEE as "a forceful research-and-development administrator who mobilized some 30,000 U.S. scientists and engineers during World War II."

☐ **Ernst A. Guillemin,** "dynamic, energetic professor of electrical engineering at M.I.T. for nearly 40 years."

☐ **William R. Hewlett,** S.M.'36, co-founder of the Hewlett-Packard Co. who holds 13 significant patents in electronic instrumentation.

☐ **Robert N. Noyce,** Ph.D.'53, founding chairman of Intel Corp., co-inventor of the integrated circuit and developer of the planar process for manufacturing transistors.

☐ **Claude E. Shannon,** Ph.D.'40, Donner Professor of Science Emeritus at M.I.T., the father of "the modern era in information theory."

☐ **William Shockley,** Ph.D.'36, who shared in the 1956 Nobel Prize for invention of the junction transistor.

☐ **Frederick E. Terman,** Sc.D.'24, an effective teacher who went on to become a leading administrator at Stanford University.

To cap its centennial activiites, IEEE made a special event of its major awards for 1984, and one of them went to **Andrew J. Viterbi,** '56, president of M/A-COM Linkabit, Inc., of San Diego. Viterbi received the 1984 Alexander Graham Bell Medal "for fundamental contributions to telecommunications theory and practice and for leadership in teaching." Viterbi is adjunct professor of electrical engineering and computer science at the University of California, San Diego, and—despite heavy administrative duties—he is credited with recent and important technical concepts.

Also to celebrate its centennial, IEEE awarded 1,984 Centennial Medals to engineers selected by IEEE's societies, sections, and major boards. Among these are countless members of the M.I.T. community—too many for publication, even for identification. But through the courtesty of **Peter L. Bellaschi,** '26, himself cited for "leadership in transformer engineering and standards," we list the Centennial Medal recipients of the IEEE Power Engineering Society:

☐ **Eugene W. Boehne,** '28, for "leadership in electric transmission technology and power engineering education."

☐ **Nathan Cohn,** '27, for contributions in control sytems development.

☐ **Andrew F. Corry,** '44, for leadership in underground distribution systems engineering.

☐ **Joseph T. Lusignan,** '24, for "distinguished contributions to the electric power discipline."

☐ **Herbert W. Woodson,** '51, for "power system education and service."

To help the IEEE celebrate its centennial year, **Donald J. Fink,** '33, the society's first general manager, was drafted out of retirement to co-author its official history, *Engineers and Electrons* (IEEE Press, 1984). He was well qualified—on the staff of *Electronics* magazine for 18 years beginning in 1934, then with Philco Corp. for 10 years before taking the reins of the new society formed in 1963 by the merger of the Institute of Radio Engineers and the American Institute of Electrical Engineers.

Agenda for Architecture: Working Together for Better Design, More Humanism

The demand for architects as designers of buildings and construction managers may seem to be declining as the U.S. economy matures. But that's illusory: society's needs for the talents that are fostered by architectural training and practice are in reality growing as constraints on resources—land, raw materials, energy, and money—tighten and as the pace of social change quickens.

Furthermore, responding to these new conditions increasingly requires a new level of collaboration among experts—designers, planners, builders, managers, and owners.

Bruce Anderson, M.Arch.'73, president of T.E.A., Inc., cites these demands in a report to Professor John R. Myer, '52, head of the department at M.I.T. They are reflected, he writes, in two challenges for architectural schools:

☐ They must focus sharply on the problems of using "form and space to address the fundamental spatial needs of people more effectively than ever before."

☐ They must cultivate in their students the ability "to design in cooperation with other people and to coordinate the entire design and construction process collaboratively."

Anderson's report results from a request two years ago by Professor Myer for a study of trends in architecture and their implications for professional training. It emphasizes the role of the core curriculum—"intensive training in the design process"—despite temptations to diversify in response to the increasing number of disciplines that affect design and construction decisions.

Under these conditions, writes Anderson, the M.I.T. department with its traditional concern for "the impact that built environments have on people and society" has a special problem: how to preserve that sense of humanism, while providing a still broader and deeper professional education. ☐

VI-A Program

The 1984 summer session saw 280 VI-A students out on company assignments at locations all over the United States and in England. Yes, Texas Instruments assigned one of their students to the Bedford, England, facility. There have been a few other foreign VI-A assignments in the past, but none since 1958. A geographical analysis of the U.S. assignments yields the following distribution: East Coast = 195 (with 110 of these in the immediate M.I.T. vicinity); West Coast = 55 (45 of these in the Silicon Valley area); Chicago/Minneapolis = 12; and Dallas/Houston/Phoenix = 18.

Come fall (when you'll be reading this) 52 of these students will be remaining at their companies pursuing their graduate assignments. Currently about 83 percent of VI-A seniors are admitted to graduate study and continue on for their combined S.B./S.M. degrees awarded at the end of the fifth year.

Professor **Jack B. Dennis,** '53, of our computer science faculty recently received the 1984 Eckert-Mauchly Award "for technical contributions to computer and digital systems architecture." This is a joint award sponsored by the Association for Computing Machinery and the Institute of Electrical & Electronics Engineers, Inc.

VI-A alumnus **George M. White,** '41, stopped by the office while attending a conference in our new E.G.&G. building in June. Mr. White holds the position of "Architect of the Capitol" in Washington, D.C. He outlined his interesting and varied career and mentioned that while attending M.I.T. he had been a roommate of **Robert W. Mayer,** '41. Mr. Mayer is currently manager of engineering at G.E.'s Pittsfield, Mass., facility where VI-A's still have assignments.

John Tucker was honored to receive from alumnus **David M. Breuer,** '74, a complimentary copy of a new book, *Introduction to Airborne Radar* just published by the Hughes Aircraft Co., long a pioneer in this field. David works in their Radar Systems Group in Los Angeles and regularly represents Hughes at the M.I.T. Career Services and Preprofessional Planning Office.

A phone call from **Patrick T. Hynes,** '81, informs us that he and **David W. Duehren,** '80, have formed their own consulting firm in Boston. . . . During a regular VI-A visit to Hewlett-Pakard's Walham (Mass.) Division, with Professor **William M. Siebert,** '46, who is VI-A faculty adviser there, Director Tucker ran across **Barry L. Wyshogrod,** '79, who is enjoying his engineering work at H-P. During the afternoon part of the visit to H-P's Andover (Mass.) Division, we met **Lawrence W. Banks,** '67. Larry serves as technical coordinator for the VI-A Program for both the Andover and Waltham Divisions.

On July 21 John Tucker had the pleasure of attending the wedding party of **Lawrence Kernan,** '75, and Ms. Jane Morse. It was a lovely affair held at the old Pierce House in Lincoln, Mass. Professor **Edward B. Roberts,** '57, and his wife were there. Ed is David Sarnoff Professor of Management in M.I.T.'s Sloan School. **Geoffrey J. Bunza,** '74, and wife were up from Phoenix, Ariz. Geof is with GenRad, Inc., in Phoenix where he is director of engineering. Joining the Bunzas, at the same dinner table with Tucker, were **Bradford E. Hampson,** '75, and his wife. Brad has bought a new home in Westford, Mass. Also attending with his wife was an old friend of John Tucker's and graduate of Course I, **Stephen B. Lipner,** '65. Steve served as president of the Tau Beta Pi Chapter at M.I.T. on whose board of directors John Tucker still serves. He was with MITRE Corp. for many years and is now with the Digital Equipment Corp., Littleton, Mass., where several VI-A's work for managers under his supervision. Quite a pleasant reunion all around!

"Cellular Enhancer" Patent Rights to Damon

Damon Biotech, Inc., now holds exclusive rights to an M.I.T. patent on a "cellular enhancer" technology discovered by Professors Stephen Gillies and Susumu Tonegawa of the Department of Biology.

Gillies and Tonegawa isolated the genetic material, or enhancer sequence, that gives some cells the ability to produce large quantities of antibodies. This enhancer sequence can be combined with genes that produce products other than antibodies. When the enhancer/gene hybrid is introduced into a particular cell, it essentially creates a factory for the manufacture of the new gene product, explains Harvey Lodish, professor of biology at M.I.T.

Before this discovery, Lodish says, it has been "next to impossible to genetically engineer mammalian cells to produce significant amounts of protein product."

The patent on cellular enhancer technology was offered by M.I.T. on a nonexclusive basis after Gillies and Tonegawa published their work more than a year ago, but there were no takers. Hence the decision to grant the exclusive license that Damon sought. Both Tonegawa and Lodish are members of Damon Biotech's Scientific Board, and Gillies has joined Damon as director of recombinant DNA research. □

On a shopping trip to Central Square one noon, Mr. Tucker met **Paul J. Sylvester,** '76, who extolled the virtues of the VI-A Program and how much it has come to mean to him. . . . We received a postcard from **Alan M. Marcum,** '78, from Washington, D.C., when he was east on a business trip.

Other visitors to the VI-A office included: **Craig B. Fuget,** '83, who is with Hewlett-Packard, Cupertino, Calif; and **Daniel G. Jablonski,** '76, who is in Washington, D.C. with the White Oak Laboratory of the Naval Surface Weapons Center.—John A. Tucker, Director, VI-A Program, M.I.T., Room 38-473, Cambridge, MA 02139

VII

Biology

Three postdoctoral research fellows in the department have received grants from the Medical Foundation of Boston, a nonprofit agency devoted to medical research and education. **Fernando Azorin** of the Department of Biology will study factors determining the formation of the DNA molecule; **Arthur M. Mercurio** will continue work on cell surface biology in the Center for Cancer Research; and **Janine Zweig** will undertake research in the Department of Biology on the mechanism by which a bacterial cell can change its surface components so as to escape a host's immune response.

Professor **Har Gobind Khorana** of M.I.T. received an honorary Sc.D. from New England College of Pharmacy last June, in recognition of "contributions to science and society."

Recent graduates who remember **Pamela Alexander,** administrative secretary in the department at M.I.T., will learn with interest that she is the winner of the 1984 Yale Series of Younger Poets competition. Poet James Merrill, this year's judge, described Alexander as "a master of perspective, never more at home than in distance. Her voice . . . puts the world in its place . . ." The winning manuscript, tentatively titled *Navigable Waterways,* was chosen out of 685 entries; it will be published next spring by Yale University Press.

Professors **Gerald R. Fink** and **Susumu Tonegawa** of the department at M.I.T. were honored late last spring by election to the American Academy of Arts and Sciences, the Cambridge-based organization to recognize achievements in the sciences and social sciences. . . . M.I.T.'s Sedgwick Professor of Biology **Alexander Rich,** recognized for his studies of the structure of nucleic acids, has been elected a foreign member of the French Academy of Sciences.

Clemens E. Prokesch, S.M.'45, an internist and senior active attending physician of internal medicine at Lawrence Memorial Hospital, New London, Conn., has been re-elected president of the Thames Stamp Club, marking his silver anniversary of service in this philatelic position.

Aurelia Cate Dawson, S.M.'34, of Seaford, Del., passed away on January 14, 1984; no further details are available.

VIII

Physics

Professor **W. Carlisle Barber,** who joined the department at M.I.T. in 1968 after a distinguished career in high-energy physics at Stanford, retired at the end of 1983-84 academic year. He's been an important contributor to M.I.T. work in experimental high-energy physics. Professor Barber studied at the Utah State Agricultural College (B.S. 1940) and the University of California at Berkeley (Ph.D. 1948) where he was W.D. Thompson Memorial Scholar in 1941-42, and he joined the department at Stanford upon completing his Ph.D.

Kyoichi Haruta, Ph.D.'63, received the Distinguished Technical Staff Award for Sustained Achievement by AT&T Bell Laboratories, Allentown, Penn. Haruta was cited as "among the first rank of engineers and scientists." His current activities have contributed "to Bell Laboratories having a state-of-the-art mask shop with capabilities that are second to none" . . . **Elliott H. Lieb,** '53, professor of mathematics and physics at Princeton University, was elected a member of the National Academy of Sciences at its annual meeting last May.

X

Chemical Engineering

Permeation technology is gaining major new importance in U.S. industry, says **Arthur D. Schwope,** S.M.'71, of Arthur D. Little, Inc. The idea is to capitalize on the fact that permeation rates through polymeric materials vary substantially depending on the polymer and the material in contact with it. A proper choice of polymers, for instance, will make a barrier that restrains all but a few desired materials. Drug delivery systems are one possible new application, Schwope told an ADL forum last spring.

XI

Urban Studies and Planning

The resurgence of central cities' retailing business has less to do with young people moving back into the cities and everyone's desire for varied shopping than it has with two policy changes: suburban restrictions on shopping mall developments, and more aggressive policies of central cities to attract builders. In a paper for the Urban Land Institute's spring meeting, Professor **Bernard J. Frieden,** Ph.D.'62, of M.I.T. says the 100-plus downtown retail projects started in U.S. cities since 1972 are a "welcome break with traditions," and the trend shows no sign of abating.

XII

Earth, Atmospheric, and Planetary Sciences

Timothy L. Grove, who joined the faculty in the field of experimental mineralogy and petrology in 1979, has been promoted to the rank of associate professor. He's won worldwide attention for abilities in studying actual volcanoes, and he has led a very popular freshman seminar since coming to the Institute.

Three members of the M.I.T. faculty retired at the end of the 1983-84 academic year: Professors **Erik Mollo-Christensen,** '48, **William H. Pinson, Jr.,** Ph.D.'51, and **Frederick Sanders,** Sc.D.'54. Mollo-Christensen's training was in aeronautical engineering, where he was a specialist in areodynamics and turbulence. The same issues, applied to meteorology and oceanography, motivated his work in this department since his appointment in meteorology in 1964; he holds the 1971 von Karman Award of AIAA. . . . Pinson came to M.I.T. in 1960 from Harvard, where he was research fellow and instructor in astronomy, and he's been associate professor in geology and geophysics since then. . . . A specialist in synoptic meteorology, Sanders is widely known for his teaching of weather forecasting and for his studies of thunderstorm systems and hurricane forecasting. He was a weather forecaster for the U.S. Air Force immediately after World War II and then for two years with the U.S. Weather Bureau before taking a research assignment at M.I.T. in 1949.

Burrell C. Burchfiel, professor of geology at M.I.T., was chosen late last spring for membership in the American Academy of Arts and Sciences, the Cambridge-based honorary society in the sciences and social sciences. Professor Burchfiel, who has taught structural geology at M.I.T. since 1977, has been named to succeed **Irwin I. Shapiro** as Schlumberger Professor of Geology. Professor Burchfiel's work concentrates on fold belts, and is yielding "a better understanding of the structure and evolution of the earth's crust," says Professor **William F. Brace,** '46, head of the department.

Professor **Gordon H. Pettengill,** '48, professor of planetary physics at M.I.T. who has made major contributions through radar mapping of the planets, is now director of the Center for Space Research; he succeeds **Herbert S. Bridge,** professor of physics, who will devote full time to teaching and research. Professor Pettengill was a member of the Lincoln Laboratory staff from 1954 to 1963 before taking major posts at the Arecibo Observatory in Puerto Rico and the Haystack Observatory at M.I.T. He joined the faculty in 1970.

Leigh H. Royden, Ph.D.'82, has joined the faculty of the department at M.I.T. as the first holder of the Kerr-McGee Career Development Professorship; she will continue her work, already underway as a postdoctoral fellow at M.I.T. and Harvard, on the evolution of sedimentary basins, including especially the conditions for petroleum formation.

William B. Farrington, Ph.D.'53, reports, "My wife Trudy is president of the Affiliates of the Laguna Beach Museum of Art. The museum has a program of improvements—I have volunteered to contact the chairmen of the major oil companies as I have known most of them over 25 years." . . . **Richard E. Stoiber,** Ph.D.'37, professor emeritus of earth sciences at Dartmouth College, Han-

over, N.H., was honored by more than 100 alumni of the college's Earth Science's Department at a symposium last April. The symposium addressed important issues in the earth sciences in the next decade, featuring lectures by leading geologists, many of them former students of Stoiber. Stoiber is best known for his field and laboratory research on volcanic gases; he has studied volcanoes all over the world.

Clifford S. Lord, Ph.D.'37, of Ottawa, Canada, passed away in 1983; no further details are available.

XIV

Economics

How to resolve the massive debts owed to American banks by developing countries in Latin America and Africa? Not by "muddling through" as we are now, says Professor **Rudiger Dornbusch** of M.I.T. We tend now to treat each country and each debt on an individual basis, says Dornbusch. But that strategy is wrong, he believes, because it creates "siege economies" instead of stimulating functioning market economies. Dornbusch's alternative: let industrial countries do everything they can to stimulate the developing countries' economies—including especially removing import barriers on goods made overseas. And let the lending banks write down some of their debts, says Dornbusch, in exchange for such freer trade policies.

John S. Reed, '64, who became chairman and chief executive officer of Citicorp last August, was introduced to *New York Times* readers as "something of a mystery man in banking." But he's no mystery around M.I.T. Reed has been a member of the visiting committee to the Sloan School of Management for nine years, was active in the Leadership Campaign in 1975-76, and has been a member of the Corporation since 1980.

Evsey D. Domar, who's been Ford International Professor of Economics since 1972 and a member of the M.I.T. faculty since 1958, retired at the end of the 1983-84 academic year. Fluent in Russian, Domar has specialized in Soviet and socialist economics as well as economic theory and fiscal policy, and he's been widely sought as a visiting professor, lecturer, and consultant.

Professor **Peter A. Diamond,** Ph.D.'63, in the department at M.I.T., was honored by election to the National Academy of Sciences last spring; his teaching is in the field of national income and finance—fiscal economics and social insurance. . . . Professor **Robert M. Solow,** is a member of the Alan T. Waterman Award Committee, appointed by the director of the National Science Foundation to choose outstanding young research workers in science, mathematics, and engineering for this prestigious prize.

William D. Nordhaus, Ph.D.'67, John Musser Professor of Economics at Yale, was honored last spring by election to the American Academy of Arts and Sciences, the national honorary in the sciences and social sciences based in Cambridge. Also during the spring, Professor Solow was made a member of the academy's Nominating Committee.

XV

Management

Three members of the Sloan School faculty have been promoted to the rank of associate professor: **Julio J. Rotemberg,** a leading macroeconomist who has specialized in the mechanisms that create business cycles and their effects on firms and individuals; **Richard Ruback,** a specialist in corporate finance and control, including mergers and takeovers; and **Thomas M. Stoker,** whose econometric research has centered on linkages between microeconomic and macroeconomic models.

Is your product poking along in a highly competitive, mature market? Then turn to systems selling, says **Terry W. Rothermel,** Ph.D.'70, of Arthur D. Little, Inc.—package your product with equipment, services, or leasing to get a leg up on the competition. The manufacturer who adopts this strategy increases his market share by increasing his sales and also by increasing the value of what he sells; he at once makes life easier for customers and harder for competitors, Rothermel told an Arthur D. Little forum last spring.

Three well-known members of the Sloan School teaching staff retired at the end of the 1983-84 academic year: **Richard Beckhard,** senior lecturer, and Professors **Edward H. Bowman,** '47, and **Eli Shapiro**. Beckhard has had extensive experience in organizational behavior and change as a lecturer and workshop leader, and he is the author of a number of major studies in the field. . . . A specialist in corporate management and finance, Bowman taught at M.I.T. from 1952 to 1966, 1969 to 1974, and since 1979. In the intervals he was comptroller at Yale University (1966 to 1969) and dean of the College of Administrative Science at Ohio State University (1974 to 1979). . . . Shapiro's first M.I.T. assignment was as professor of finance from 1952 to 1961, when he was also associate dean of the Sloan School (1954 to 1957). He returned to the faculty in 1976, when he was also vice chairman of the board of the Travelers Insurance Companies, to hold the Alfred P. Sloan Chair. Trained as an economist at Brooklyn College and Columbia University, Shapiro is a specialist in finance.

Coping with the Fear of Mathematics

Most young children easily acquire the basic meaning of numbers—symbols. They learn fractions when they share cookies, even averages when they follow baseball.

Why, then do so many adults have trouble with learning or relearning mathematics?

They suffer from "math anxiety," says Miriam Lipschutz Yevick, Ph.D.'47, associate professor of mathematics at Rutgers University. According to Yevick, "Anxieties are transmitted from parents to children and from teachers to students, and once started, math anxiety builds on itself so that the adult student has to deal with an accumulated fear." To help such people, Yevick developed an introductory course, "Mathematics for Life and Society," which she teaches to undergraduates at University College—an evening division of Rutgers.

In her class, Yevick initially approaches mathematics with practical applications, not in terms of the often "frightening" and "overwhelming" abstract symbolism of x's, y's, and operators. She talks about the consumer price index, national deficits, and interest rates—topics all her students know about. Once these ideas are in place, Yevick introduces the comparison between the practical and more abstract, which by now is easier for the students to grasp. "I might talk about three or four concepts for any given problem . . . without the students initially being very much aware of what I'm doing. Although we're dealing with a concrete situation, we try to look at it in a general abstract fashion," Yevick says.

Yevick tries get her students to understand the meaning of the symbol by beginning with the history of writing—"how ideographs and pictographs were used before letters came to represent sounds. I then show them how in mathematics we use letters—x and y—as symbols that represent numbers," Yevick says. "While I love mathematics as an abstract structure," she says, "I'm also very much interested that our students learn the skills that relate to their jobs and real life, and that they get a handle of quantitative skills that will benefit them in their daily lives." Her students, Yevick says, "are amazed at their often-sudden comprehension. It's fascinating to see their faces when they understand the concept."

Yevick's dedication to her philosophy that "everyone should understand math" comes from her belief that "to solve the world's problems today, we need the informed participation of large numbers of citizens. To be informed means to be able to use quantitative tools in rethinking the world."—*V.K.* □

Sloan Fellows

George T. Haymaker, Jr., S.M.'69, former vice-president—international, of the Aluminum Co. of America has become executive vice-president heading the aluminum group at Alumax, Inc., San Mateo, Calif.

Robert O. Black, S.M.'70, writes, "Recently appointed principal assistant deputy for research, development, and acquisition at the U.S. Army Material Development and Readiness Command." . . . **Kenneth A. Isaacs,** S.M.'75, has been promoted from manager of corporate budgets and control to vice-president and heavy group controller at the Perini Corp., Framingham, Mass. Prior to joining Perini in 1979, Isaacs was a member of the audit and consulting staff of Arthur Anderson & Co., also serving as project manager for another construction firm. . . . **Richard J. Santagati,** S.M.'79, has been named president of NYNEX Business Information Systems, White Plains, N.Y., the NYNEX subsidiary which markets business terminal equipment and service. Santagati served as vice-president for marketing for New England Telephone prior to his appointment to NYNEX.

William Zarkowsky, S.M.'58, retired last spring as vice-president of Grumman Aerospace Corp., Milledgeville, Ga. He was named recipient of the Golden Key Award by the Georgia College Alumni Association at its annual Alumni Weekend last April and plans to teach a special seminar in the Georgia College School of Business. Among his many affiliations, Zarkowsky served as president of Grumman Aerospace and of Grumman Eco

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Systems Corp., and he continues as a Grumman director. He is a member of the Georgia College Foundation Board of Trustees, the Georgia College School of Business Advisory Cabinet, and Economics for Executives Forum. . . . **Jon D. Helms,** S.M.'51, has been appointed chemicals vice-president of Sun Refining and Marketing Co., Philadelphia, Penn., a subsidary of Sun Company, Inc. Helms, who joined Sun in 1957, held numerous engineering and managerial positions, and in his new post will oversee Sun's chemical business, the majority of which involves the sales of commodity petrochemicals.

Management of Technology Program

Your program manager took a jaunt to Scotland this summer, where she was able to catch up with a couple of Pilkington graduates of the program. **Charles A. Berry,** S.M.'83, and his wife, Irene, expected their first baby on July 24. When I talked with them by phone they both sounded very excited. Charles is still enjoying his new position with Pilkington, and they have made the move now to North Wales. . . . I had dinner with **Charles R. Bow,** S.M.'84, in Glasgow. Charles was very happy to be back with Barr and Stroud, where he was delighted with his new position as product strategy manager for the nondefense side of the business. By the way, **Ted Finch,** S.M.'84, had just been in Glasgow with Charles before I got there and was then off on a tour of the country before returning to Boston to start his new job as investment analyst for State Street Research and Management.

In other program news, **Moises J. Goldman,** S.M.'84, took a position as director of forward planning for the Dukane Corp. in the Chicago area, and said that he and his family were looking forward to the move to Chicago. **John A. Harrison,** S.M.'83, broke ground last May for an addition to his new house in Princeton Junction, N.J. He said he was enjoying his work with Parsons Brinckerhoff in Philadelphia, where he is project director for the Pennsylvania High-Speed Rail Feasibility Study. . . . **Koichi Kodama,** S.M.'84, took a job with Mitsubishi International Corp., New York City, as manager of technology. He explained that it's a newly created position reporting directly to the president and will involve much travel to Japan, which he was looking forward to.

Carol M. Lemlein, S.M.'83, spoke to me this summer by phone to say that her position at Teradyne was continually increasing in scope and, though she was constantly surprised at how much busier it gets, she was loving it. . . . **Julian N. Nikolchev,** S.M.'83, was in Britain on business last spring and managed a side-trip to North Wales to see the Berrys. He and Charles Berry stopped in on **Geoff Andrews,** S.M.'82, and his family, who also live in North Wales.

As a quick note to all of you, the current class is enrolled and working hard by now. There are 20 individuals, several sponsored by companies such as RCA, Advanced Energy Technology, Pilkington, and Rhone-Poulenc and some here on their own. We have several countries represented in the group, including France, Scotland, Argentina, Japan, and Singapore, though 70 percent are U.S. citizens.

Please let us know whenever you come to the Boston area. I'm sure the current class would love the opportunity to meet you. And we need to keep hearing from *all* of you.—Jane Morse, Program Manager, M.I.T., Room E52-125, Cambridge, MA 02139

XVI

Aeronautics and Astronautics

Promotions to associate professor became effective during the summer for two members of the department at M.I.T.: **Edward F. Crawley,** '76, who has established himself as an authority in the vibration and damping of composite materials, turbo-machine rotors, and structures under zero-gravity conditions; and **Alan H. Epstein,** '71, an experimentalist who has made major contributions to understanding fluid mechanics and heat transfer in aircraft compressors and turbines.

Two long-time members of the M.I.T. faculty retired at the end of the 1983-84 academic year: Professors **Morton Finston** and **Robert L. Halfman,** '44. Finston is a specialist in heat transfer and fluid mechanics who came to M.I.T. as a research associate in 1949; he's been here ever since, attaining the rank of full professor in 1963. . . . Halfman, whose specialty is flight dynamics, has recently been chairman of the Experimental Studies Group and associate dean while continuing teaching and research in the department. Halfman had a major role in the development of the Indian Institute of Technology at Kanpur, acting for M.I.T. with a consortium of American universities seeking to upgrade this technical institution, and he has served as executive officer and deputy head of the department.

XVII

Political Science

Joshua Cohen and **Richard J. Samuels,** Ph.D.'80, have been promoted to the rank associate professor in the department at M.I.T. Cohen holds a joint appointment between economics and the Department of Linguistics and Philosophy, providing a bridge between political science and political philosophy; Samuels heads the M.I.T.-Japan Science and Technology Program.

XVIII

Mathematics

Three members of the department faculty at M.I.T. have been promoted to the rank of associate professor: **David Jerison,** whose research interest is in the field of partial differential equations; **Frank Morgan,** '74, who has been recognized for his undergraduate teaching and his research on minimal surfaces; and **Ka-Kit Tung,** a specialist in geophysical fluid mechanics and hydrodynamic stability.

Professor **Francis B. Hildebrand,** Ph.D.'40, widely respected as a teacher in the department at M.I.T. for over 40 years, retired at the end of the 1983-84 academic year. His work was in the field of aerodynamics and elasticity, and he was the author of three successful texts in calculus, numerical analysis, and applied mathematics.

XXI

Humanities

Two members of the department's Literature Section have been promoted to associate professor on the M.I.T. faculty: **Amy S. Lang,** a specialist in American literature of the pre-Civil-War period who has taught at the Institute since 1978; and **William J. Paul,** who is bringing his background in literature to the study of film and film history.

Technology and Policy Program

David Hanrahan, S.M.'79, is involved in a consulting job with the City of Shanghai to develop a municipal liquid waste management strategy. . . . **Carrick Davidson,** S.M.'80, has been selected as editor-in-chief of *The Review of Litigation,* a law review published at the University of Texas Law School. . . . **Richard Davies,** S.M.'84, has received a civil service appointment to participate in the public inquiry regarding the construction of the Sizewell B nuclear reactor in Suffolk, England. . . . **Barbara Herrmann,** S.M.'81, has become co-owner of a clothing store called Pepperweed in Cambridge, Mass.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA 02139

Beaver Found

Our first "Find This Beaver!" contest (*October, 1983, page A18*) drew 17 correct entries. Sandra Yulke, '74 was the first to correctly identify the Astor line of New York City's subway as the home of this beaver, and the $25 that came to the Alumni Fund from sponsor Leigh J. Passman, '81, was credited to the Class of 1974 Scholarship Fund.

The Astor castors, symbol of the Astor family, commemorate John Jacob Astor, one of 19th-century New York's richest citizens, benefactor of the N.Y. Public Library, and subway proponent. Astor made much of his vast fortune in the fur trade and in the process, writes Gordon Burck, '75, "denuded Oregon of its state animal."

Terra cotta plaques decorate Lexington line stations from lower Manhattan to Grand Central. William J. Mitchell, E.E.'77, proposes that the plaques served a practical as well as aesthetic purpose: they were a way for illiterate riders to determine that they had reached the proper stop.

Five Years from Vietnam to an EECS Fellowship

In 1978 Chi Chris Luu was on a small fishing boat escaping from Vietnam. Now—six short years later—he's arrived at M.I.T. to hold the prestigious Schlumberger Fellowship for graduate study in electrical engineering and computer science.

Until this fall Chi has lived with his parents and three of his four brothers in a one-room apartment in the Elmhurst section of Queens (New York City). He and two brothers escaped from Vietnam aboard fishing boats that took them—one by one—to Malaysia. They won admission to the U.S. in 1979, settled in Queens, and in 1980 were joined by their parents and younger brother, all of whom had earlier escaped to Taiwan.

Chi began his U.S. schooling in 1980 at La Guardia Community College, where he polished his facility in English, a language he couldn't speak at all when he left Vietnam. By January 1981 he was ready for admission to City College of New York to major in electrical engineering. Less than four years later he had his bachelor's degree with a 3.98 (near perfect) average, as well as membership in two national engineering honor societies—Tau Beta Pi and Eta Kappa Nu. All the while, Chi was working part-time to help support his family—tutoring mathematics, doing clerical work at CCNY, and taking various outside sales jobs.

Chi's perserverance and accomplishment despite barriers of poverty and language were widely noted at CCNY's commencement last June, where he delivered the valedictory address in English—and then private remarks of tribute to his parents in Chinese. □

Rushing to Engineering

Members of the Class of 1987 are continuing the trek to the School of Engineering—and especially to its Department of Electrical Engineering and Computer Science.

By the end of last Spring Term, 877 freshmen had listed their majors; 575 of these had opted for study in the School of Engineering, including 287 in the Department of Electrical Engineering and Computer Science. (The remaining 196 students in the class of 1,073 will choose majors this fall; the choice must be made by the end of the Fall Term of the sophomore year.)

The demand for majors in the School of Engineering—and particularly in the Department of Electrical Engineering and Computer Science—has been a matter of serious concern because it leads to overcrowding and a warping of the traditional balances between schools and departments. But after extended debate

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M. D. Bucknam, '81
N. A. Campagna, Jr. '67
F. W. Clark, '79
W. E. Hadge, '79
W. E. Jaworski, '73
C. A. Lindberg, '78
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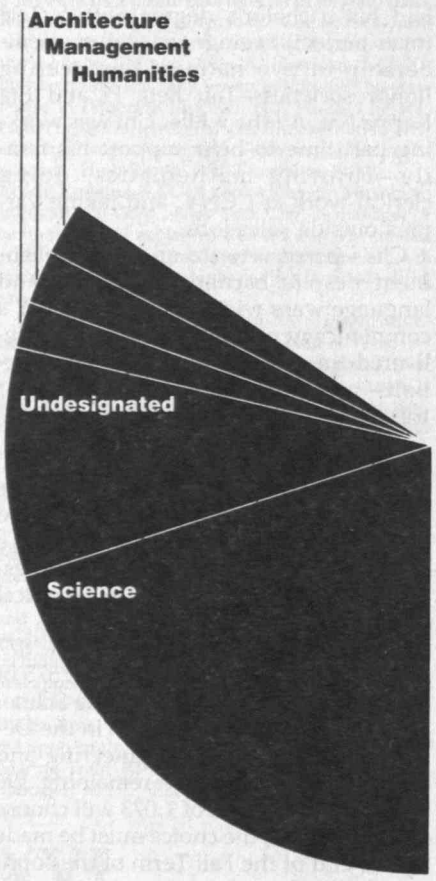
last year, the faculty refused to modify the traditional freedom to choose a major given to every M.I.T. undergraduate. Instead, late last spring the faculty agreed to consider a "contingency" plan should enrollments become still further unbalanced. That plan, now being drafted by the Committee on Educational Policy, is to "rely primarily on restrictions placed during the admissions process and communicated to students before they accept admission," according to the faculty's instructions. □



When the time came to pick majors last spring, members of the Class of 1987 continued the march to engineering. Only the 35 percent of the class shown above opted for non-engineering majors, and nearly one-third of this year's sophomores chose electrical engineering and computer science.

Blacks Losing Ground

Except in all-black colleges, minorities rarely hold decision-making positions in U.S. colleges and universities. What's more, affirmative action is losing ground on most U.S. campuses, too.

A bleak picture, says Clarence G. Williams, special assistant to the president at M.I.T. At too many places, he says, affirmative action is "on the back burner"—out of sight and so out of mind. But that's not where it belongs, Williams insists. Hence his leadership, and M.I.T.'s sponsorship, of conferences for black administrators at predominantly white colleges.

About 800 such administrators showed up for the 1984 conference last summer, the third in an annual series. They were urged by James Blackwell, professor of sociology at the University of Massachusetts in Boston, to press their own institutions to identify and encourage promising black students and to provide mentors and more resources, such as financial help and housing. □

1035 Frosh; 28% Women

As this issue of the *Review* went to press, Peter H. Richardson, '48 retiring director of admissions, expected the Class of 1988 to number between 1,035 and 1,040 when freshman orientation began on August 31.

The class will be notable for including more women than in any previous year—about 28 percent, Richardson told *The Tech* late in the summer. About 100 will be minorities—blacks, Mexican-Americans, Puerto Ricans, and American Indians.

By contrast, the Class of 1987 numbered 1,075, only 22.5 percent of them women.

Some 300 students applied to transfer to M.I.T. beginning this fall, and 106 of these were admitted. No transfer applicants were accepted for electrical engineering and computer science—a decision that reduced transfers by as many as 50, thinks Daniel T. Langdale, associate director of admissions.

Mason Haire, 1916-1984

Professor Mason Haire, a pioneer in the application of psychology to the problems of management who taught at the Sloan School of Management for more than a decade, died at his retirement home in Walnut Creek, Calif., in June. He was 68.

Professor Haire studied psychology at Swarthmore (A.B. 1937) and Harvard (M.A. 1940, Ph.D. 1942). He first joined the M.I.T. faculty in industrial relations in 1946, teaching here until taking a post at the University of California, Berkeley, in 1949. Sixteen years later he returned to M.I.T. as visiting professor, and in 1967 he rejoined the faculty as professor of organizational psychology and management. He became Sloan Professor of Management in 1970, six years before his retirement.

"He always had innovative methods for looking at the way people relate to organizations and organizations to the world," said the Sloan School's Dean Abraham J. Siegel. "His work and his leadership were crucial to the development of a vital area for the school."

Asit Sarkar, 1960-1984

Asit Sarkar, a graduate student in physics from Calcutta, India, died on June 21; he was 24.

Sarkar was founding editor of two campus publications for graduate students—*Octavian*, a journal of student research in physics; and *The Graduate*, a magazine for all graduate students published by the Graduate Student Association. Sarkar won a 1983 William L. Stewart Award for his contributions.

Samuel C. Collins, 1898-1984: Engineer of Low Temperatures

Samuel C. Collins, professor of mechanical engineering at M.I.T. from 1930 to 1964, died in Washington, D.C., on June 19 of cancer; he was 85.

It was shortly after World War II that Collins developed and built a simplified and reliable machine for liquefying helium—the first such machine that could be widely used without expert mechanics standing by. Collins liquefiers are familiar now in thousands of universities and reasearch laboratories, and they are in large part responsible for the flowering of cryogenics—the science of extremely low temperatures. "A real pioneer," said Howard O. McMahon, Ph.D.'41, formerly vice president of Arthur D. Little, Inc., in speaking of Collins, who took his helium liquefier to ADL for commercial development.

Following retirement from the M.I.T. faculty, Collins worked at the Naval Research Laboratory, Washington.

Deceased

William C. West, '11; June 26, 1984; 671 SW 6th St., VT 514, Pompano Beach, Fla.
Merrill J. Smith, '13; May 23, 1984; 938 South Kihei Rd. No. 610, Kihei Maui, Hawaii.
Lester T. Forbes, '14; June 16, 1984; 55 Davis Rd., Merrimack, N.H.
Manuel V. Arguelles, '15; c/o Arguelles Laboratory, 800 Raon St., Manila, Phillipines.
Arthur L. Nelson, '15; 1984; Nelson Ranch, Blanco, Tex.
Eldred M. Peterson, '15; May 1979; 32 Arlington St., Newton, Mass.
Joel W. Campbell, '17; January 2, 1984; 623 Monte Vista Ave., Fort Collins, Col.
Kingsley Gillespie, '17; April 30, 1984; c/o WSTC, 117 Prospect St., Stamford, Conn.
Carl Phelps, '19; February 2, 1984.
Francis T. Hill, '21; October 13, 1983; 14 Ware St., Cambridge, Mass.
Harold A. Tucker, '21; June 28, 1983; 214 Grove St., Belmont, Mass.
Earl E. Mader, '22; September 12, 1983; 104 Myrtle Dr., Thomasville, Ga.
Francis J. Kurriss, '23; July 25, 1983; 644 Willow Glen Rd., Santa Barbara, Calif.
George H. Holmes, Jr., '24; February 17, 1984; 529 Pearson Rd., c/o Don Travers, Paradise, Calif.
C. Julian Oberwarth, '24; April 23, 1984; 501 Springfield Rd., Eutaw, Ala.
Henry B. Robinson, '24; September 6, 1983; 1701 Colonial Rd., Raleigh, N.C.
Seymour Floyd Stewart, '24; July 28, 1980; 445 Pioneer Trail, Aurora, Ohio.
Paul B. Goble, '25; April 24, 1984; 51 Village Green, Southern Pines, N.C.
Donald J. McNeil, Jr., '25; May 24, 1984; 190 Harvard St., No. 304, Brookline, Mass.
Wilder E. Perkins, '25; February 1983; 1000 Green Pond Rd., c/o Stan Perkins, Newfoundland, N.J.
Judson T. Biehle, '26; June 10, 1984; 332 Kelly St., Hawthorne, N.Y.
George W. Breck, '26; May 13, 1984; 900 Intracoastal Dr. Apt. 7, Fort Lauderdale, Fla.
Alfred W. Gass, '26; May 23, 1984; 638 Colrain Rd., Greenfield, Mass.
Edgar B. Godley, '26; September 29, 1983; 1503 Juniper Dr., Alamogordo, N.M.
John B. Pearson, Jr., '28; March 23, 1984; 281 S Barrington Apt. C-6, c/o Beverly Fraasa, Los Angeles, Calif.
Frederic D. Riley, '28; June 1984; RT 1, Box 740, Weems, Va.
Walter H. Gale, '29; July 11, 1984; PO Box 251, Melvin Village, N.H.
Raymond Underwood, '29; December 24, 1983; 339 Meadowwood Ln., Souderton, Penn.
Arsene W. Morin, '31; April 22, 1984; 8911 Northeastern Blvd. No. C203, Albuquerque, N.M.
Arthur T. Newell, '31; July 5, 1984; 27 College Rd., Wellesley, Mass.
Frederick B. Simmons, '31; April 1, 1980; 130 Auckland St., Apt. 319, Dorchester, Mass.
Thomas R. Stearns, '31; June 10, 1984; c/o TR Stearns & Son, 250 Old Oaken Bucket Rd., Scituate, Mass.
Morley G. Taylor, '31; May 7, 1984; 354 Purcells Cove Rd., Halifax, Canada.
Oliver Morfit, '32; June 5, 1984; Village Rd., Green Village, N.J.
Cornelius J. Griffin, Jr., '33; May 2, 1984; 761 Aster St. No. 172, Oxnard, Calif.
James H. Merritt, '33; March 24, 1984; 1867 Jefferson St., San Francisco, Calif.
William T. Barry, Jr., '34; November 6, 1983; 318 Mill Rd., Hampton, N.H.
Paul D. Germond, '35; June 15, 1984; 279 Audubon Rd., Englewood, N.J.
Elmo C. Mitchell, '36; September 21, 1983; 2008 Lyle Ave., College Park, Ga.
David C. Hill, '37; May 17, 1984; 3903 Durham Pl., Flintridge, Calif.
Dean A. Lyon, '37; June 9, 1984; Childs Hill Rd., RT 2, Box 22A, Woodstock, Conn.
Abraham L. Baird, '39; October 31, 1983; 734 18th St., Santa Monica, Calif.
Thomas J. Greene, '40; December 4, 1983; 2562 Paxton St., Woodbridge, Va.
Charles H. Strang, '40; May 13, 1984; 75 Martin Rd., Milton, Mass.
Roy M. Tuttle, '40; June 5, 1984; 87 Hillcrest Rd., Windsor, Conn.
Harold E. Dato, '41; April 26, 1984; c/o Glenbrook, Inc., 375 W Liberty St., PO Box E, Wauconda, Ill.
E. Kirkbride Miller, Jr., '41; June 12, 1984; 307 Overhill Rd., Baltimore, Md.
Lloyd E. St Jean, '42; April 29, 1984; 2 Laurel Hill Ln., Milford, N.H.
Earl C. Roberts, '50; June 2, 1984; 24914 SE 422nd, Enumclaw, Wash.
Carl Engelman, '51; November 26, 1983; 29 Alpine St., Cambridge, Mass.
Robert B. Martindale, '57; July 9, 1984; 2714 NE 103rd, Seattle, Wash.
Leonard D. Spar, '61; July 17, 1984; 228 Escallania Dr., Novato, Calif.
David C. Hu, '70; April 29, 1980; 1871 San Antonio, Berkeley, Calif.
Michael Sims, '72; December 19, 1982; 17 Martha Ln., Evanston, Ill.
Dan L. Du Boff, '76; July 14, 1983; c/o Jack Du Boff, 1115 W Orchard Ln., Peoria, Ill.
Barbara J. Archer, '84; July 12, 1984; 306 Highland, Moorestown, N.J.
Asit Sarkar, '84; June 21, 1984; 550 Memorial Dr., Apt. 4C, Cambridge, Mass.

Ten Years Later, Whitaker Health Sciences Fund Still Unique and Still Growing

Funding research is like landing your first job: nobody wants to give you money until you have a proven track record, and you can't establish a track record unless your research has been funded. Even after you have published research, you must return to square one if you want to move in a new direction or do something novel, like analyzing heart muscle as if it were a solid-state electrical device.

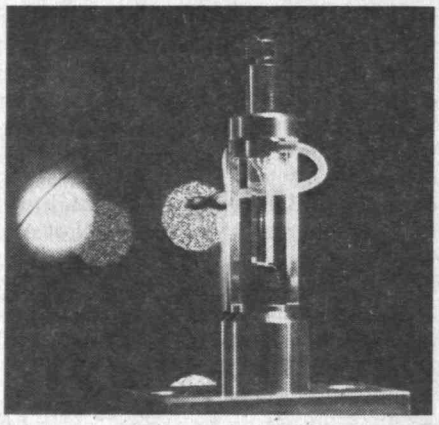
In 1974, Uncas A. Whitaker, '23 launched a fund that addresses all those obstacles to research and more. On October 10, the fund celebrates its tenth anniversary by bringing together many of the now-distinguished researchers whose careers and whose fields owe much to Whitaker's vision.

The Whitaker Health Sciences Fund (WHSF), as it came to be known after its founder's death, has staked out a unique piece of turf: it concentrates on research conducted by promising young investigators and doctoral students, which is interdisciplinary and innovative, which brings the insights and methods of science and engineering to bear on biomedical problems, and which involves joint investigations by M.I.T. faculty and collaborators from the medical schools of Harvard, Boston University, and, starting in 1985, Tufts.

Far from being overshadowed by the billions dispensed by the National Institutes of Health (NIH) and the National Science Foundation (NSF), WHSF has provided bridge financing which enabled researchers to compete successfully for grants from these more traditional funding agencies.

The continuous involvement of the Whitaker family (Uncas was succeeded by his late wife Helen and most recently by his daughter, Ruth Holmes, as a member of WHSF's independent Board of Trustees) and the commitment of the original officers, notably the president of the board, Irwin Sizer, retired dean of the Graduate School, have helped the fund to preserve its unique character.

This year, the fund is providing close to $1.2 million for 16 doctoral fellows and 19 faculty members and their collaborators, and the Board expects its programs to grow by 50 percent over the next three years.



Eerily beautiful by laser light, this optical-pulse particle size analyzer was developed by biophysicist Richard Cohen with support from the Whitaker Health Sciences Fund. (See also facing page.)

Among those invited to the WHSF birthday party will be the 210 faculty members and 92 graduate students who have received support. What follows is a sampler of their work that illustrates the impact of Whitaker's vision.

Cholesterol: Just Try Going Without

In spite of all the bad press cholesterol receives, you couldn't get along without it. It is a vital component of all mammalian cell walls, and your cells are even equipped to manufacture their own cholesterol if the supply produced in your liver or extracted from your diet drops too low.

For all its importance, cholesterol metabolism isn't fully understood, and it is the focus of research by one of the 1984-85 WHSF doctoral fellows, David Kingsley. Kingsley is working in a group headed by Whitaker College faculty member Monty Krieger. The group is prying into the fundamental processes by which cells utilize the cholesterol traveling through the bloodstream encased in carrier molecules of Low Density Lipoprotein (LDL).

They are concentrating on the role of the receptors on the cell surfaces which identify and bind the LDL to sites on the cell membrane. The receptor and the LDL molecule are then drawn into the cell, where enzymes break down the carrier to free the cholesterol.

Kingsley and his colleagues are isolating mutant cells that are unable to take up LDL because of defects in some cellular component. By comparing the mutants to normal cells, they are painstakingly reconstructing the cholesterol-uptake pathway, and they have now identified four genes required for this process.

Behind this basic research is the hope that it will eventually contribute to the treatment of heart disease. A particularly dramatic illustration of the link between LDL receptors, cholesterol and heart disease is provided by "familial hypercholesterolemia," Kingsley says. As a consequence of defects in at least one of the LDL receptor genes, patients with this condition cannot bind and take up available cholesterol. Their cells, reacting as if there were absolutely no cholesterol in the diet, produce their own cholesterol, while that in the bloodstream eventually builds up in blood vessel walls and constricts flow. Five percent of all heart attacks in the U.S. can be traced to patients with one defective LDL receptor gene, Kingsley reports, and patients with two defective genes usually die of heart disease before they reach age 20.

The Physics of Cataract Disease

Your doctor probably wouldn't tell you that you are suffering from "aggregation and phase separation of protein molecules in the lens of your eye, leading first to clouding then to opacification of the lens." A doctor would say cataract disease, but the result is the same: blindness. George B. Benedek and his students are looking for a means to disrupt the disease's inevitable course.

For Benedek, who is the Alfred H. Caspary Professor of Physics and Biological Physics, this is one of three main lines of research which have benefited from WHSF support over the years.

Quinn is looking for differences between the brains of mutants and those of more intellectually accomplished fruit flies.

Graduate student Michael Broide is able to deduce the size of clustering particles by measuring the intensity of light they scatter as they pass through the laser beam. This work has wide applications in chemistry, physics, and—of particular biomedical interest—the immune response.

PHOTOGRAPHS: FRANK REVI, '86

The second area deals with the mechanism for the formation of micelles, molecules which transport lipids in the gastrointenstinal tract and in the blood. Defects in this molecular transport system can result in gallstones and cholesterol deposits on blood vessel walls.

Clumping of molecules is also involved in the third area of Benedek's research, which deals with the interactions between antigens and antibodies. His group has developed a practical, sensitive immunoassay which uses antigens and antibodies to test for various compounds circulating in the body fluids. Their test has the potential to replace radio-immunoassay, one of the most widely-used tests in modern clinical practice.

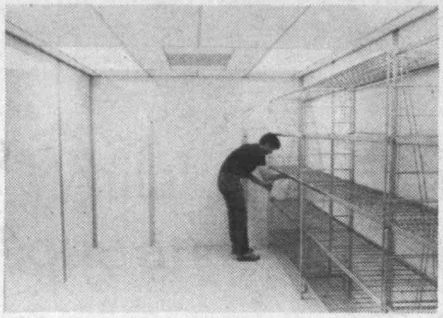
Gloryland of Opportunity in the Brain

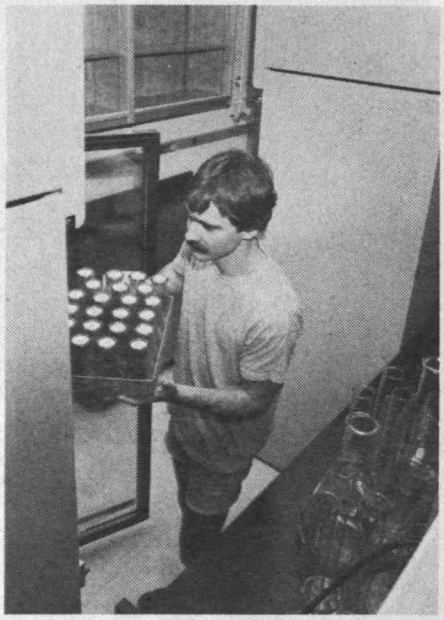
Monoclonal antibodies, "lock and key molecules manufactured to grab onto specific cells in the body," present a "gloryland of opportunity to the brain researcher," according to researcher Ann M. Graybiel, Ph.D.'71.

"We don't know enough about the molecules in the brain," explains Graybiel, professor of psychology and brain science, "nor do we know the concentrations of various compounds that determine how brain cells develop and function as groups." By developing monoclonal antibodies to detect molecules expected in the brain, and hooking on to the antibody a molecule that can be seen, such as a die or a fluorescent marker, neuroscientists have a means of looking into the brain, particularly at what is happening when a neurotransmitter is working.

We know that neurotransmitters are the functioning message units of the brain, Graybiel explains, and that sufferers from Parkinson's disease are deficient in the transmitter dopamine, while patients with Alzheimer's disease have inadequate supplies of the transmitter acetylcholine. By studying the distribution of brain compounds in relation to other transmitters with which they are known to interact, Graybiel hopes to shed further light on the theory

Young hopes his research will lead to protocols for feeding badly burned children to help them recover.





The new neurobiology lab of William Quinn was in a very rudimentary state in mid-August, as post-doctoral fellows Randy Smith (top) and Peter Cartinhour sorted out work areas and furniture and nurtured fruit flies.

that imbalances among those transmitters lead to disease.

"We had no money at all," Graybiel says of her work with collaborator Linda Chun of the Harvard Medical School. But thanks to the WHSF, "it has blossomed into a real research effort" for which she has applied for outside funding with every hope of success.

Intellectual Fruit Flies, Apply Here

William Quinn is looking for a "unitary trick"—one, simple, fundamental chemical or physical change in their brain cells that allows animals to store memory. In other words, to learn.

Until July of this year he was looking for it at Princeton. But as of late summer he had a laboratory, three post-doctoral fellows, and the first of several graduate students fully engaged in the Whitaker College of Health Sciences, Technology, and Management.

Working with mutant fruit flies whose mutations impair their ability to learn or remember such tasks as avoiding odors associated with electrical shock, Quinn's group is looking for the chemical, physiological, or anatomical differences between their brains and those of more intellectually accomplished fruit flies.

Quinn expects that having access to the expertise and potential collaborators in M.I.T.'s top-ranked DNA research group will help him "up the ante" in his investigations by developing the capability to clone the genes of particularly valuable lines of fruit fly mutants.

Moving an operation of this sophistication is expensive, and $40,000 start-up grants from the WHSF are helping Quinn get his research into high gear on this campus.

Treating Burn Victims Through Diet

There was a time when the recommendations for human protein consumption were nothing more than recordings of what hospital patients ate. That was considered "normal." It was a step in the right direction when animal studies were used, but projecting human needs from studies with rats is just not precise.

The most recent revisions in the U.N.'s international standards for minimal protein requirements however, have a solid foundation in the work of Vernon Young and his collaborators on human protein metabolism.

Young is professor of nutritional biochemistry, and his research group looks at the total picture: how the body uses protein, the differences in utilization of animal and vegetable protein and how much of each the body should have, the nutritional requirements for amino acids, and the capacity of various foods to meet human needs.

They work with volunteers who put themselves under the care of the medical staff at M.I.T.'s Clinical Research Center for varying periods of time. The volunteers are put on strictly defined diets, injected at certain intervals with specific amino acids which are tagged with stable, non-radioactive isotopes and then monitored to see how their bodies process the nutrients.

Young also studies the impact of trauma on protein metabolism, a line of investigation which can make big emotional demands on the laboratory scientist. He found it very hard, for example, to maintain his usual detachment when he began to study the nutritional status of severely burned children, measuring their nutrient loss and trying to understand the mechanisms by which they lose nutrients. But he trained himself to concentrate on the research, which he hopes will lead to protocols to help children recover.

The bulk of Young's graduate students are M.D.'s or medical students pursuing degrees in nutritional biochemistry. WHSF support enables them to work in an intense research environment, which Young says often leads them to become lifetime researchers, a career pattern that is not usually fostered in medical schools.

Each time he moves in a slightly different direction, Young finds the support of the WHSF particularly valuable. "It gives me the opportunity to test new hypotheses and generate a body of work that can then win funds from more traditional sources," he says.—*Susan Lewis*

ALLAN J. GOTTLIEB

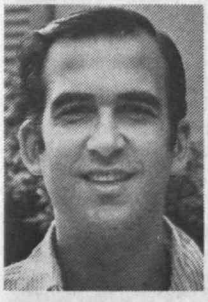
The King of Marbles Takes a Queen

Since this is the first issue of a new academic year. I once more review the ground rules under which this department is conducted.

In each issue I present five regular problems (the first of which is chess- or bridge-related) and two "speed" problems. Readers are invited to submit solutions to the regular problems, and three issues later one submitted solution is printed for each problem; I also list other readers whose solutions were successful. For example, solutions to the problems you see below will appear in the February/March issue. Since I must submit that column sometime in November (today is July 20), you should send your solutions to me during the next few weeks. Late solutions, as well as comments on published solutions, are acknowledged in the section "Better Late Than Never" in subsequent issues.

For "speed" problems the procedure is quite different. Often whimsical, these problems should not be taken too seriously. If the proposer submits a solution with the problem, that solution appears at the end of the same column in which the problem is published. For example, solutions to this issue's "speed" problems are given below. Only rarely are coments on "speed" problems published or acknowledged.

There is also an annual problem, published in the first issue of each new year; and sometimes I go back into history to republish problems which remained unsolved after their first appearance.



ALLAN J. GOTTLIEB, '67, is associate research professor at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y. 10012.

All problems come from readers, and all readers are invited to submit their favorites. I'll report on the size of the backlog, and on the criteria used in selecting solutions for publication, in a future issue.

Finally, let me correct an error from the July issue: Mr. Yoshigahara has named me "world puzzler" number *8*, not number 6 as stated in July.

Problems

OCT 1. We begin with a bridge problem from Howard Sard, who wants to know the minimum number of high-card points needed to make a contract of 7 spades against the best defense.

OCT 2. Here's one that appeared under the title "A Parable of Marbles" in the M.I.T. Physics Department student newsletter edited by Minn Chung, '80:

Once upon a time there lived a king whom everybody called the King of Marbles. He decorated every wall and floor of his palace with colorful marbles and paved the roads to the palace with gold marbles. But his obsession over marbles had an interesting history. You see, when he was just a kid, his mother, the queen, spanked him whenever he played with marbles. But after his mother had died and he had become king there was no one to stop him from playing with marbles. So his libido exploded, and one fine evening he made a declaration to his subjects: "Here I have a hollow semi-sphere with a hole at the bottom. I shall drop this marble into the sphere. If any of you can stop the marble from dropping through the hole without touching it, I shall make you a very rich person." Many clever people tried various ingenious techniques such as looking at the marbles standing upside down, attempting to build an antigravity machine, and praying to whomever would listen. Obviously, none of them worked—until it was Mitsy's turn. Mitsy was not only clever but she was very wise—she knew physics from 8.01, you see. She built a machine with which she could rotate the sphere, and when the king dropped the

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marble into the rotating sphere, the marble stopped rolling exactly halfway from the bottom. So Mitsy became very rich and famous (the king liked her so much he wanted her to be queen), and everybody lived happily ever after.

Question: Assuming the frictional coefficient between marble and sphere is μ and the radius of the sphere is R, find the maximum angular velocity of Mitsy's sphere.

OCT 3. Jonathan Hardis offers us a problem from the realm of applied probability or theoretical gambling:

In the Illinois Lottery Lotto game, the player chooses six different integers from 1 to 40. If the six match, in any order, the six different integers drawn by the lottery, the player wins the grand prize jackpot which starts at $1 million and grows weekly until won. Multiple winners split the pot equally. For each $1 bet, the player must pick two, presumably different, sets of six integers. Considering the grand prize alone, under what conditions would it pay, on the average, to play this game? In the game week ending June 18, 1983, 78 people matched all six winning integers and split the jackpot. Estimate the odds of this outcome, given that 2 million people bought $1 tickets that week.

OCT 4. Mearle Smith has a problem involving an "associate research professor" (I wonder where she got the funny title and why it is that I don't like the solution to the problem):

An associate research professor walks into his office one morning and says to his secretary, "I had three dinner guests last night. The product of their ages was 2450. The sum of their ages was twice your age. Can you tell me their three ages?" Ten minutes later his secretary came to him and said that she could not solve the problem. He said, "You are right. I will now tell you that I was the oldest one there." She was then able to tell him the ages of the three dinner guests. What are the ages of the three dinner guests, her age, and the professors's age?

OCT 5. Irving Hopkins asks: Given an irregular polygon of n sides, in which sequence should the sides be arranged and how should the corner angles be determined to give the greatest area?

Speed Department

SD 1. Bruce Calder writes:

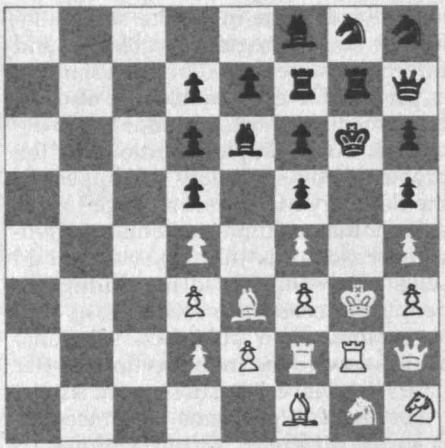
A telegram attached to a crate containing six canisters of 1000 pellets each reads: "Crate may contain canisters of defective pellets. Defects weigh 1 milligram (+/− 1 nanogram) less than proper 1 gram (+/− 1 microgram)." Using a scale accurate to 100 micrograms, what is the minimum number of weighings required to identify the defective canisters?

SD 2. What's wrong with Lester Steffen's "proof" that any number x must equal 2. Recall from alegebra I that $a^{b^c} = a^{bc}$. If we let a = b = c, we get $x^{x^x} = x^{xx} = x^{x^2}$. Thus x must be 2.

Solutions

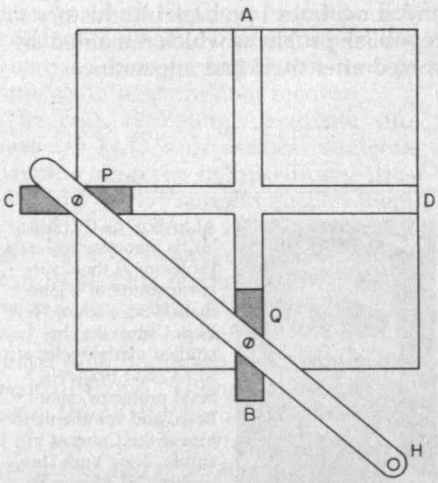
M/J 1. Given all 32 pieces, place them on the chess board in such a way that neither player can move or capture a piece. Pawns can be on any rank and doubled, tripled, even quadrupled upon the same file. No piece can be considered a promoted pawn (use of three bishops and only seven pawns is illegal).

Although pawns were allowed on any rank, I have chosen Richard Hess's solution primarily because he alone was able to avoid the normally illegal first and last ranks:

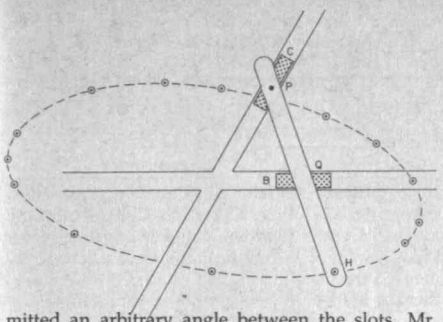


Also solved by Everett Leroy, Samuel Levitin, Matthew Fountain, Roger Spellman, and the proposer, John Walz.

M/J 2. Analysis of the device shown below proves that the orbit of H is an ellipse as H is rotated to a full 360° with travellers B and C moving in their respective slots. If the two slots are at 60° instead of 90° the figure similarly drawn (*top of page A31*) seems to be an ellipse, and if the axes are of the same length the two ellipses seem to coincide. Prove whether the 60° configuration is a true ellipse. Can the tilt of the major axis be calculated?

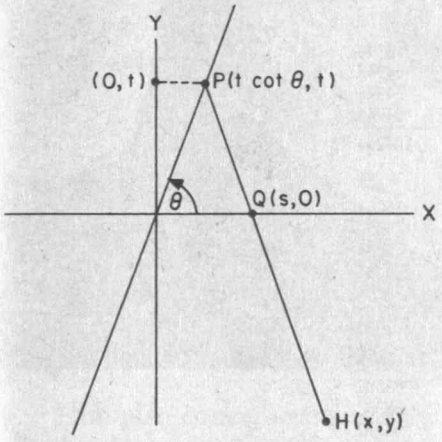


Preventing a further generalization of this problem in 1985 or 1986, Charles Sutton and others per-



mitted an arbitrary angle between the slots. Mr. Sutton writes:

Considering a more general problem, let's assume one slot is inclined at an angle θ to the other slot. Choosing coordinates as shown in the diagram, let the projection of P on the y-axis be (O,t) and the coordinates of Q be (s,O). Then the coordinates of P will be (t cot θ,t), and we can let the coordinates of H, the equation of whose path we wish to find, be (x,y).



Letting the fixed distance from P to Q be a, we have

$(t \cot \theta - s)^2 + t^2 = a^2$ (1)

Also, letting the ratio of the lengths of PH to PQ be r and expressing the condition that P, Q, and H are colinear, we have

$x - t \cot \theta = r(s - t \cot \theta)$ (2)

$y - t = r(0 - t)$. (3)

Multiplying (3) by cot θ and subtracting from (2) gives $x - y \cot \theta = rs$, which when solved for s gives

$s = (x - y \cot \theta)/r$. (4)

Solving (3) for t gives

$t = y/(1 - r)$. (5)

Substituting the values of s and t from (4) and (5) into (1) and simplifying we obtain the cartesian equation of the curve:

$(r - 1)^2x^2 + 2(r - 1)(\cot \theta)xy + (r^2 + \cot^2\theta)y^2 - a^2r^2(r - 1)^2 = 0$ (6)

Comparing this with the standard form of the second-degree equation $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, we find that the discriminant $B^2 - 4AC = 4(r - 1)^2\cot^2\theta - 4(r - 1)^2(r^2 + \cot^2\theta) = -4r^2(r - 1)^2\cot^2\theta$, which is clearly negative, showing that (6) represents an ellipse. Again, the angle α through which the coordinate axes must be rotated to remove the xy term from equation (6), and hence make the axes of the ellipse coincide with the coordinate axes, is given by

$\cot 2\alpha = (A - C)/B = (1 - 2r - \cot^2\theta)/[2(r - 1)\cot \theta]$, (7)

which depends on both r and θ. When θ = 60°, cot θ = $\sqrt{3}/3$ and (7) becomes

$\cot 2\alpha = [(1 - 3r)\sqrt{3}]/3(r - 1)$, (8)

from which the angle α can be calculated. For example, when PQ = QH, so r = 2, cot 2α = $5\sqrt{3}/3 = -2.88675$, so 2α = −19.107° and α = −9.553°; so the major axis of the ellipse will be inclined at this angle to the horizontal slot (the x-axis). If r becomes very large, cot 2α will be nearly $-\sqrt{3}$ so approximately 2α = −30° and α = −15°. Note also that r can be less than one, implying that point H is between P and Q. Thus if r = 1/3, cot 2α = 0 so 2α = 90° and α = 45°.

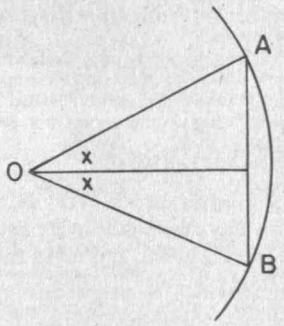
Also solved by Karl Brendel, John Langhaar, Matthew Fountain, Winslow Hartford, Harry Zaremba, William Peirce, and Richard Hess.

M/J 3. Find the Maclaurin series for sin and cos *without* using calculus or higher mathematics, although the concept of limits may be used. By way of an analogy, $(1 + x/n)^n$ can be expanded using the bionomial theorem for n a positive integer (hence derivable without calculus) to give, after simplifying

$1 + x + (1 - 1/n)\,x^2/2! + (1 - 1/n)(1 - 2/n)x^3/3! + \ldots$,

which, upon letting x approach infinity, becomes the Maclaurin series for e^x.

Several readers noted that sin and cos can be expressed in terms of the exponential via complex analysis. I am printing two proofs using more elementary approaches, one geometric and the other based on DeMoivre's theorem (which can be proved using just the double angle formula and the definition of i). First we have from Matthew Fountain:



In the figure AB is a chord on a circle of unit radius. The area of triangle OAB is both (1/2) sin 2x and (sin x)(cos x). Thus,

$(1/2)\sin 2x = (\sin x)(\cos x)$. (1)

From this equation is derived

$\cos 2x = 2\cos^2 x - 1$. (2)

As chord AB on the unit circle decreases in length, its length approaches that of arc AB, sin x approaches x, and cos x approaches $(1 - x^2)^{1/2}$ or, equivalently, $1 - (1/2)x^2$. This shows that the power series for cos x must begin

$\cos x = 1 - (1/2)^2x^2 + \ldots$

Also, as $\cos x = \cos -x$, the power series contains only even powers of x. Setting

$\cos x = 1 - (1/2)x^2 + ax^4 + bx^6 + \ldots$

in equation (2) results in

$1 - (1/2)(2x)^2 + a(2x)^4 + b(2x)^6 + \ldots =$
$2[1 - (1/2)x^2 + ax^4 + bx^6 + \ldots]^2 - 1$.

Equating coefficients of terms of similar power,

$16a = 4a + (1/2)$,
$64b = 4b - 2a, \ldots$

Solving, a = (1/24), b = (−1/720), . . . This gives the Maclaurin series,

$\cos x = 1 - (1/2!)x^2 + (1/4!)x^4 - (1/6!)x^6 + \ldots$

The power series for sin x contains only odd powers of x as $\sin x = -\sin -x$. Setting

$\sin x = x + rx^3 + sx^5 + tx^7 + \ldots$

and substituting in equation (1),

$(1/2)[2x + r(2x)^3 + s(2x)^5 + t(2x)^7 + \ldots]$
$= [x + rx^3 + sx^5 + tx^7 + \ldots][1 - (1/2!)x^2 + (1/4!)x^4 - (1/6!)x^6 + \ldots]$.

Equating coefficients of terms of similar power,

$4r = -(1/2) + r$,
$16s = (1/4!) - (1/2)r + s$,
$64! = -(1/6!) + (1/4!)r - (1/2)s + t. \ldots$

Solving, r = −(1/3!), s = (1/5!), t = −(1/7!), . . . This gives the Maclaurin series,

$\sin x = x - (1/3!)x^3 + (1/5!)x^5 - (1/7!)x^7 + \ldots$

The second solution is from Harry Zaremba: The series can be determined by using DeMoivre's theorem,

$\cos n\theta + i \sin n\theta = (\cos \theta + i \sin \theta)^n$.

If the right side is expanded and the real parts of the left and right sides are equated, we have

$\cos n\theta = \cos^n\theta - [n(n - 1)\cos^{n-2}\theta \sin^2\theta]/2! + [n(n - 1)(n - 2)(n - 3)\cos^{n-4}\theta \sin^4\theta]/4! + \ldots$

Let $x = n\theta$. Then $\theta = x/n$ and $n = x/\theta$ in which x is to remain constant while n and θ vary. Substituting the values into (1),

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$$\cos x = \cos^n\theta - \frac{\frac{x}{\theta}\left(\frac{x}{\theta} - 1\right)}{2!}\cos^{n-2}\theta \sin^2\theta + \frac{\frac{x}{\theta}\left(\frac{x}{\theta} - 1\right)\left(\frac{x}{\theta} - 2\right)\left(\frac{x}{\theta} - 3\right)}{4!}\cos^{n-4}\theta \sin^4\theta + \ldots$$

$$\cos x = \cos^n\theta - \frac{x(x-\theta)}{2!}\cos^{n-2}\theta \left(\frac{\sin\theta}{\theta}\right)^2 + \frac{x(x-\theta)(x-2\theta)(x-3\theta)}{4!}\cos^{n-4}\theta \left(\frac{\sin\theta}{\theta}\right)^4 + \ldots$$

If $n \to \alpha$, then $\theta \to 0$, $\cos\theta \to 1$, $\sin\theta/\theta \to 1$, and $(x - \theta) \to x$. Therefore
$\cos x = 1 - x^2/2! + x^4/4! - x^6/6! + \ldots$
If the imaginary part of the left side is equated to the imaginary parts of the expanded right side, and similar limits are applied, the result will be
$\sin x = x - x^3/3! + x^5/5! - x^7/7! + \ldots$

Also solved by John Prussing, Charles Sutton, and Richard Hess.

M/J 4. Consider the number $8888^{8888} \equiv A$. Suppose you were able to write it in decimal form. Then suppose you add its decimal digits together and therefore construct their sum $\equiv B$. Again, write B in decimal form and add its decimal digits to form a new number C. Repeat this step once more (add the decimal digits of C to form a new number). What is this last number?

The following solution is from Douglas Ell:
My first step was to obtain a rough estimate of the magnitude of the solution, which I labeled "D." The number 8888^{8888} has no more than 4×8888 digits and thus
$B \leq 4 \times 8888 \times 9 < 320{,}400$.
Continuing,
$C \leq 2 + 5 \times 9$; $D \leq 13$.
Let R be the function on the positive integers obtained by continuing the process described above (converting A to B to C to D) until a single-digit number is obtained. Note that this process consists of subtracting various multiples of 9. Thus $R(m) = n$, where $m \equiv n \pmod 9$ and $1 \leq n \leq 9$. Also, if i and j are positive integers, $R(i \times j) = R(R(i) \times R(j))$ and thus $R(i^j) = R[(R(i))^j]$. If follows that $R[8888^{8888}] = R[5^{8888}] = R[R(5^2) \times R(5^6 \times {}^{1481})] = R[R(25) \times 1] = 7$. (Note that $5^6 \equiv 1 \pmod 9$.) Because D is at least a partial step in obtaining $R(8888^{8888})$, it follows that $D \equiv R(8888^{8888}) \pmod 9$.
Putting together both $1 \leq D \leq 13$ and $D \equiv 7 \pmod 9$, we see that $D = 7$.

Also solved by Karl Brendel, John Langhaar, Harry Lieberman, Steve Fieldman, Frank Carbin, David Simen, Matthew Fountain, Harry Zaremba, Richard Hess, and the proposer, Anthony Beris.

M/J 5. "None of my children is over twenty," said Mr. Euclid, "and I notice that this year the sum of the cubes of the ages in years of the younger three is equal to the cube of the age of the eldest." "I can't tell their ages from that information," said his friend Mr. Diophant, "even though I know the age of the eldest of your four kids." What was the age of Mr. Euclid's third child?

I find it fitting that Caryln Iuzzolino let Pascal help out Euclid and Diophant:
The program I wrote is

```
program ijkl (input,output);
var i,j,k,l:integer;
begin
for i: = 1 to 20 do
for j: = 1 to i do
for k: = 1 to j do
for l: = 1 to k do
if i*i*i=j*j*j+k*k*k+l*l*l
then writeln(i,j,k,l);
end.
```

The output:

6	5	4	3
9	8	6	1
12	10	8	6
18	15	12	9
18	16	12	2
19	18	10	3
20	17	14	7

Since the friend couldn't tell the ages, even though he knew how old the oldest child was, the oldest child must have been 18 and therefore the third oldest was 12 years old.

Also solved by Karl Brendel, Robert Slater, Richard Hess, Matthew Fountain, Harry Zaremba, Evan Klein, Edward Amrein, Avi Ornstein, Yale Zussman, Mel Garelick, Clarence Cantor, Phelps Meaker, Dennis Sandow, Winslow Hartford, John Prussing, Steve Feldman, Frank Carbin, David Simen, Samuel Levitin, Frank Conlin, Gardner Perry, Richard Marks, and the proposer, John Hughes.

Better Late Than Never

1982 OCT 2. The proposer (who has had trouble getting his *Review* in Japan) reports that he "was astonished to see" the solution given in the March 1983 issue. He enclosed the following solution and asks us to pay particular attention to the *n given in the sums.

```
   13744
   64948
   64948
+  64948
  104294 *2

     645
   75054
   75054
   75054
   75054
+  75054
  125305 *3

   84502
   84502
   68387
   68387
   68387
+ 818387
  298138 *4

    5394
    5394
   24947
   24947
   24947
   24947
  404947
+ 404947
  184094 *5
```

1983 JAN 1. The proposer Doug Van Patten responds to Ruth by Turner's query. North should have been declarer, not South. North started the bidding with a club and East-West competed. After bidding clubs twice, North tried a 4-spade bid, which his partner accepted. So the bidding was natural—no contorted systems! The position of the declarer does not affect the solution.

F/M 4. Phelps Meaker has responded.

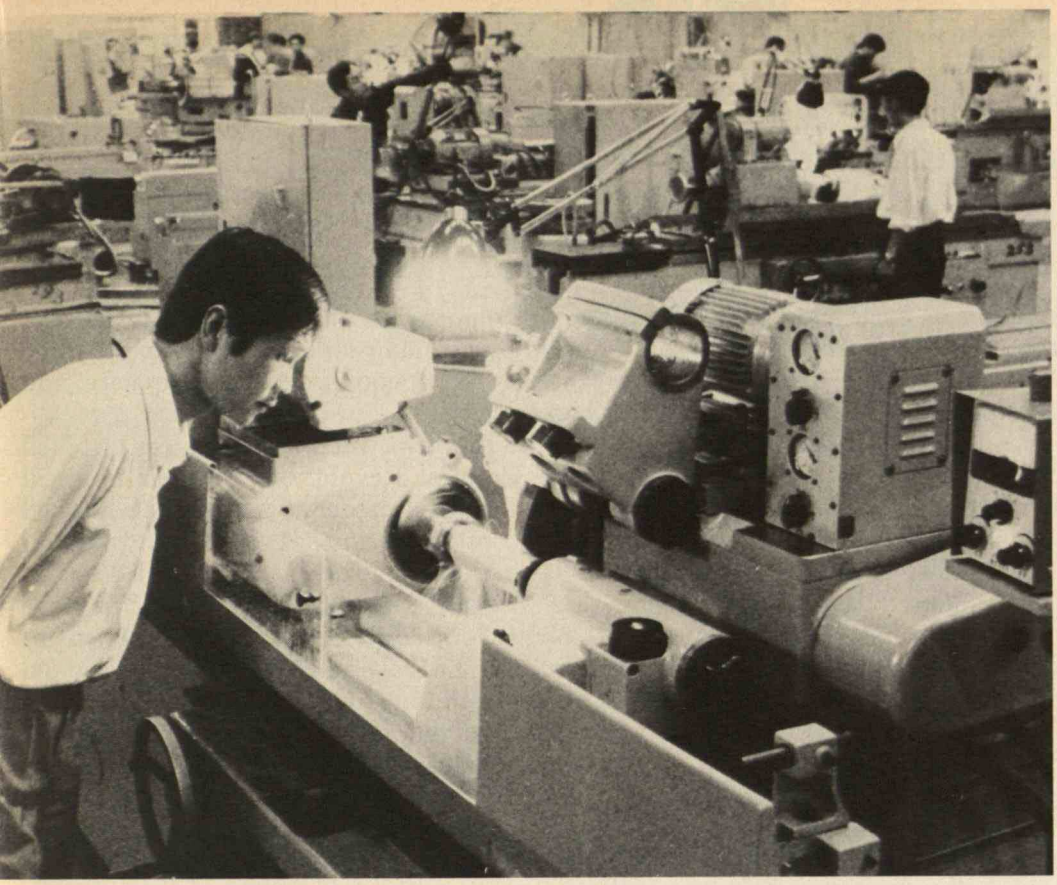
APR 4. Howard Stern has responded.

M/J SD1. J. Lawrence and H. Shaw report that the answer is 5.

Proposer's Solutions to Speed Problems

SD 1. One weighing suffices. Mark the canisters 1, 2, 4, 8, 16, and 32, and remove the respective number of pellets from each. The number of milligrams less than 63 grams uniquely identifies the defective canisters. For example, if scale reads 62.9730765 grams, then 27 milligrams shy. Therefore 27 = 16 + 8 + 2 + 1 so the canisters marked 1, 2, 8, and 16 are defective.

SD 2. $x^{xx} = x^{(x^2)} = x2^{x^2}$



The United States must compete with Japan and Western Europe to establish relations with Chinese industry. The Japanese have been particularly successful. Far left: A Japanese technician at the Fujian Hitachi Television Co. passes along skills to a Chinese worker.

As the Chinese improve the quality of products ranging from textiles to electronics and increase their exports, they themselves will compete on world markets. Left: These grinding machines are already being produced by the Shanghai Machine Tools Plant for export to the United States.

I am also concerned about the military aspects of technology transfer. The Chinese are asking for increasingly high technologies: 75 percent of their requests are for microelectronic circuits, computers, various electronic instruments, and equipment for producing semiconductors. Even more than nuclear technologies, these can be used in military as well as civilian areas—particularly for strategic weapons such as the intercontinental ballistic missiles (ICBMs) the Chinese have already deployed.

The U.S. government is concerned that the Soviet Union may put American technology—whether smuggled computers or information gleaned from open scientific literature—to military use. It should be similarly concerned about the actions of China. Even though that country appears friendly to the United States now, it has a legacy of policy reversals, from antagonism to the West during the late sixties under Chairman Mao Zedong to the demise of Mao's apparent successor Hua Kuofeng and the emergence of Deng's open-door policies today. Deng is old; conflicting factions still exist; and China's future is hard to predict, especially in view of the vast amount of change occuring there today. Under the circumstances, I think the United States should be more careful about giving the Chinese high technology that could be used as a building block for further developing strategic weapons. Should Sino-American relations sour, that technology could not be taken back.

China's Struggle to Modernize

To help China develop its industry but not its strategic weapons, Americans must understand something of the country's erratic yet impressive efforts to adapt advanced technologies. It has been a story of shifts between self-reliance and foreign borrowing, of competition between factions favoring radical nationalism and those favoring foreign intercourse.

After the Communist revolution in 1949, some 11,000 Soviet technicians went to China to help build about 150 major industrial plants. However, the Soviet Union pulled out in 1960, teaching the Chinese a costly lesson in self-reliance. While they ultimately proved adept at finishing Soviet designs through trial and error, they did so with great difficulty, and they were locked into Soviet technical specifications and a cumbersome research system for a long time.

In the early sixties China began importing plants on a modest scale from two new sources—Western Europe and Japan. Then in 1966 came the debilitating turmoil of the Cultural Revolution. Chinese universities and research institutions were closed, scientists and intellectuals were criticized, and China went into a period of deep isolation, closing its doors to foreign technology.

In 1972, the Chinese again embarked on a major campaign to purchase foreign plants and equipment. They acquired some $3 billion worth of foreign

PHOTOS: A/P WIDE WORLD

When the Wuhan Iron and Steel Mill was finally built, the managers discovered that it needed more electricity than was available in the entire province.

plants to help boost production of basic industrial commodities such as fertilizer and petrochemicals. However, the so-called "Gang of Four," including Mao's wife and other leaders, soon began criticizing the import of technology, and imports dropped again until after the death of Mao and the arrest of the radical Gang of Four in late 1976.

Since that time, under Deng's influence, Chinese imports of technology have steadily risen. In February 1978 the Chinese leaders adopted the so-called "four modernizations" program that focused on agriculture, industry, science and technology, and national defense. China set the goal of bringing its technology and defense up to the same level as the West's by the year 2000.

Though science and technology were listed third among the four modernizations, in March 1978 China's political and scientific leaders attended a national science conference and declared that "the crux of the four modernizations rests with science and technology development." Much of this science and technology was to come from abroad. Indeed, by 1978 what Westerners have called the "giant Chinese shopping spree and fishing expedition" was well under way, as China purchased some $7 billion in plants and equipment, and scientific and economic delegations fanned out into Western countries.

However, this approach to buying technology was flawed, as the Chinese themselves have been most astute in realizing. The purchase of whole plants and equipment, which had been emphasized since Soviet days, rarely worked as expected.

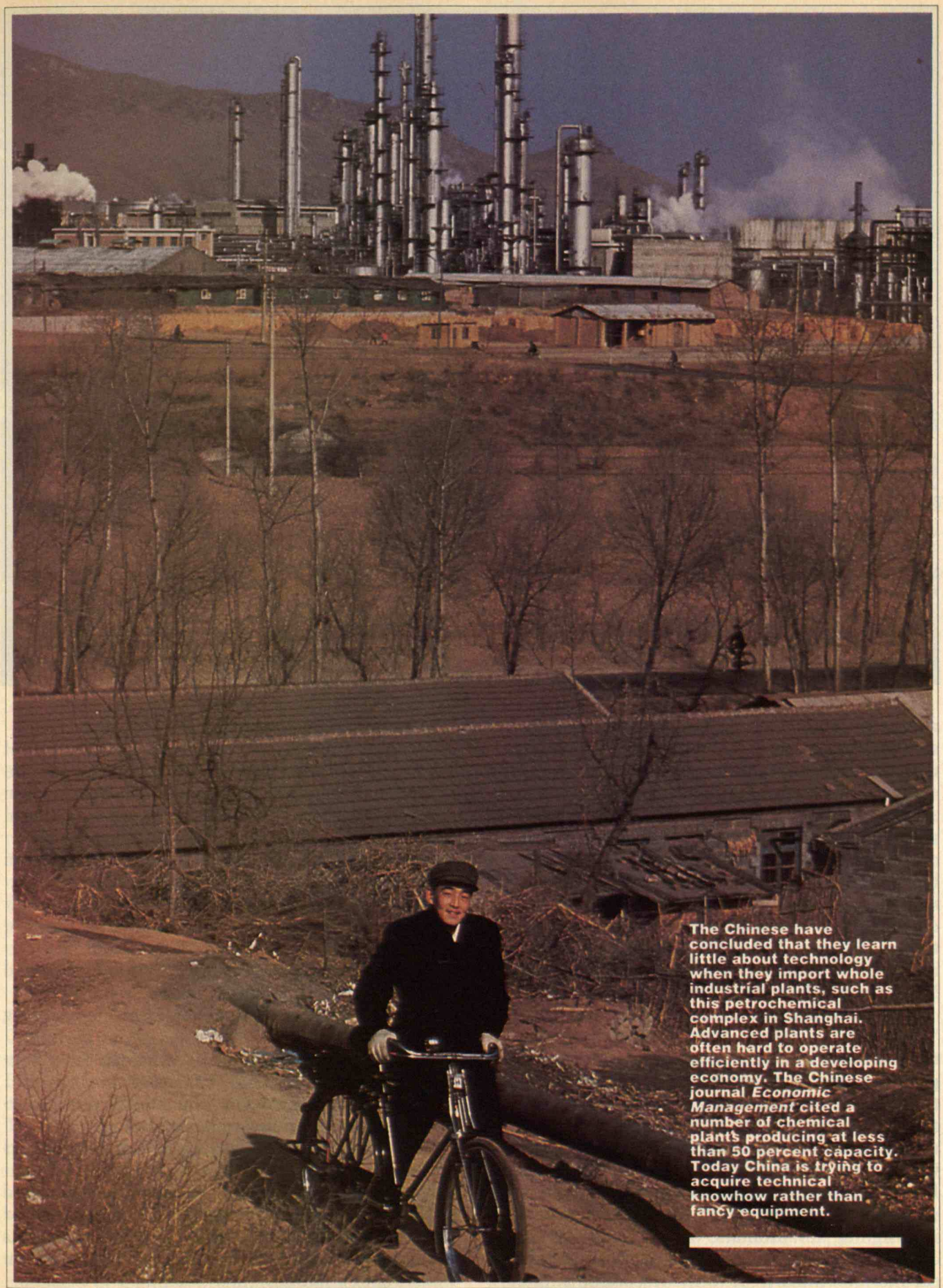
For example, the Wuhan Iron and Steel Mill, begun under the Soviet Union in the fifties and upgraded in the seventies with Japanese and West German assistance, epitomized the problems the Chinese have encountered in buying whole plants. The mill took almost twice as long to complete as expected, and when it was ready in 1979 the managers discovered that it needed more electricity than was available in the entire Hubei province. New and old parts of the plant were poorly integrated, air pollution was severe, and some of the types of steel produced turned out to be useless. For instance, wide, thin sheets could not be used in Chinese canning factories, which dated back to the thirties. The mill often had to shut down for lack of spare parts or had to run at reduced capacity for lack of iron ore. Indeed, *Economic Management*, a Chinese business journal, reported in 1981 that only 25 percent of imported plants had produced an acceptable rate of return, most were operating below capacity, and many had fallen behind in construction.

Part of the problem was that managers installed during the Cultural Revolution for their political rather than technical credentials were ill equipped to manage complex plants. A more fundamental problem lay in the very attempt to swallow advanced technologies whole. An article in the July 1982 issue of the Chinese journal *Research on the Problems of Finance and Economics* argued that foreign-supplied plants often fail to improve productivity. According to the author, textile mills that the Chinese bought from foreign suppliers cost more, used more energy, required more workers, and deteriorated more quickly than indigenous mills. Also, integrating foreign-supplied plants, which are often in effect indivisible units, into a less advanced economy can be difficult. Such concerns prompted *Beijing Review* editorials to comment that the Chinese were spending too much money on acquiring "eggs" and too little on "hens"—technical knowhow. An article in *Economic Management* in mid-April 1981 estimated that only 2 percent of the total funds spent on technology imports during 1978 had truly gone for acquiring "technology" rather than for packaged plants and equipment.

Another problem the Chinese have had in assimilating technology stems from the structure of their research system. Contrary to the Western impression that it is oriented toward practical applications, this system has a certain ivory-tower mentality. For example, one goal that Chinese leaders chose to emphasize at the national science conference in 1978 was high-energy physics. Leading Chinese scientists, many of whom were trained abroad in the 1930s and 1940s, wanted to jump back into the world scientific community and perhaps even win Nobel Prizes.

The rigid research structure that remained from the Soviet period was isolated from industry. Research institutes had little incentive to serve factories, and factory managers, concerned mainly with meeting output quotas—the quality and performance of products mattered little—were not disposed to risk adopting new technologies.

By December 1978, only 10 months after the optimistic four modernization goals were formally



The Chinese have concluded that they learn little about technology when they import whole industrial plants, such as this petrochemical complex in Shanghai. Advanced plants are often hard to operate efficiently in a developing economy. The Chinese journal *Economic Management* cited a number of chemical plants producing at less than 50 percent capacity. Today China is trying to acquire technical knowhow rather than fancy equipment.

PHOTO: LIU/CONTACT

adopted, Chinese leaders had begun to realize that something was amiss. They decided to settle for attaining Western technology of the seventies and eighties by the year 2000 and to stress applied research. They have steered away from purchasing whole plants and equipment, and instead want to acquire more intangible aspects of technology—technical skills and management methods—along with selected items such as advanced materials, microelectronics, and computers that might solve particular problems. The sixth five-year plan announced in late 1982 reinforces this approach and calls for linking research to the economy.

A prime mechanism for creating this linkage is the "responsibility system" in production that places enterprises and research institutes more nearly on a profit-and-loss basis. Factories now have incentives to improve products and introduce new ones, and they can contract with research institutes for new technologies. For example, in Sichuan province the Chongqing Spark Plugs Factory and Chongqing Low-Pressure Container Factory agreed to work with the Chongqing Machinery Research Institute in designing an automatic welding machine to produce spark plugs. Four percent of the sales value of the first 100 units went to the research institute.

The New Import Strategy

Beijing has also established new policies for importing technology in recent years. As laid down in 1982 by Xu Deen of the China National Technical Import Corporation, these policies state:

☐ China will not sign contracts that restrict it from using imported technologies for research.

☐ China reserves the right to use any technology and retain associated documentation after the contract expires.

☐ Agreements must guarantee that the imported technology will suit China's needs.

☐ China will not accept tie-in agreements requiring additional purchases.

☐ China reserves the right to switch to other suppliers.

☐ Suppliers must inform China of any improvements or modifications in the technology.

☐ China will not accept any agreement that restricts the end-use of a technology.

These stipulations reflect the country's increased sophistication in the international marketplace, and they are consistent with the Third World's attempts to increase its leverage in acquiring technology from industrialized nations.

PHOTO: *CHINA BUSINESS REVIEW*, COURTESY OF NATIONAL COUNCIL FOR US-CHINA TRADE

Far left: Technicians at the Beijing Institute of Electronic Computer Technology assemble microcomputers. Shanghai, Tianjin, and Beijing are vying to create their own Silicon Valleys.

Above: China needs far more computers for civilian industry and government; this IBM was purchased to tabulate the national census. However, the military has placed a high priority on electronics and could well benefit from technologies that are imported for civilian purposes.

Left: Donald Sorterup, general manager of a joint venture between the Foxboro Co. of Foxboro, Mass., and a company in Shanghai, trains Chinese officials using a computer-operated system for controlling industrial processes such as those used in manufacturing food, paper, or oil.

To acquire information about technology, China has established cooperative science and technology efforts, similar to the one with the United States, with all major industrialized nations. Beijing has also become involved in international scientific and technological activities, particularly through the United Nations, and the Chinese have established industrial-management programs with developed nations similar to the U.S.-China industrial-management program in Dalian. These programs could make a real contribution, as management has been the Achilles' heel of China's modernization effort.

The Chinese have arranged for scholarly exchanges with universities such as the University of California at Berkeley; for information exchanges with professional societies such as the Institute of Electrical and Electronic Engineers; and even for special commercial ties with cities, states, and provinces. The Chinese Institute for Scientific and Technical Information in Beijing has been charged with securing leading foreign scientific and technical journals and conference proceedings, and Beijing has made a special effort to cultivate foreign nationals of Chinese origin. For example, in late 1983 China held a conference specifically for foreign scientists and engineers of Chinese origin, and Deng emphasized the importance of ties with this community.

Because of these efforts, the Chinese are making substantial gains in their ability to absorb Western technologies, though it is hard to tell exactly where all this will lead. A couple of years ago the first Chinese translation of Alvin Toffler's *The Third Wave* caused quite a stir. At a national seminar in Beijing early this year, China's highest leaders and top thinkers spoke about making the transition to "third-wave" technologies. Some fear that if they do not move forward in information technology, microelectronics, biotechnology, and new materials, the West and Japan will pull even further ahead. Thus, Shanghai, Tianjin, and Beijing are vying to create their own "Silicon Valleys."

At the same time, some party leaders still committed to Maoist principles fear that China has gone too far too fast in adopting foreign technologies. Such technologies, they maintain, will be accompanied by other "bourgeois" forces as well as corruption and crime. Indeed, black markets are springing up for products such as color televisions. In the thirties and forties, the Nationalist regime under Chiang Kai-shek crumbled in part through corruption associated with the West. Some Maoist-leaning officials also fear the effect of imports on

PHOTOS; FOXBORO COMPANY; OWEN FRANKEN, STOCK BOSTON

The U.S. government wants to improve relations with China, as highlighted by President Reagan's recent trip there. However, in their concern over diplomatic issues, policymakers often pay too little attention to bargaining over the thing the Chinese most desire from the United States: technology.

China's domestic industries. They point out that many Chinese forego domestically made items such as computers for more expensive and prestigious foreign-made products.

However, Deng's government asserts that the current open-door policy is an integral part of China's long-term development strategy; Chinese leaders feel obliged to assure foreigners of this because of the reversals of the past. When a recent political campaign to head off "spiritual pollution" from capitalist trading partners got a bit out of hand, China's leadership made it clear that all science and technology would be exempt from attack.

The Sleeping Tiger

Since 1978 China has made numerous efforts to assess and in some cases acquire foreign military technology. The Chinese have discussed the possibility of purchasing weapon systems such as the French Mirage 2000 jet fighter and the U.S. antitank TOW missile. When Chinese Defense Minister Zhang Aiping visited the United States this year, he met with counterparts at the Pentagon and visited military contractors. Such visits have allowed the Chinese to gain state-of-the-art information about the performance of Western weapons and defense research. Over the last five years, academic, government, and business hosts to Chinese delegations have noted a steady improvement in their technical sophistication.

In addition to exploding nuclear weapons, the Chinese have deployed ICBMs, and in October 1982 they successfully launched a ballistic missile from a submarine. They have been able to do this despite their problems in implementing civilian technology because their centralized system can concentrate its best-educated scientists and most advanced resources on high-priority projects. According to a recent report by the Chinese Ministry of Ordnance Industry, the defense sector has better scientists and technical personnel, superior manufacturing and testing equipment, and greater financial support than the civilian sector.

The military also draws freely from—and contributes to—the civilian sector. For example, the Chinese Academy of Sciences, which employs most of the country's scientists who were trained in the West before the Communist takeover, is ostensibly a civilian organization and the focus of basic research. Yet any of the academy's 117 research institutes may be required to work on China's advanced weapons programs. Because other military and civilian research institutes are sometimes located in the same buildings, it is hard to restrict the use of a technology to civilian purposes. In addition, the Chinese have made it clear that they consider any requirements about the use of a technology to be an interference in their internal affairs.

It is true that in the four modernization efforts the military was listed last, and military spending seems to have been cut. However, this appears to be mainly a waste-reduction and productivity-improvement program while the military concentrates on strengthening its research and industrial foundation. Zhang, former head of China's military research and development, has now been made minister of the entire defense establishment, and in 1982 several organizations were amalgamated and apparently strengthened in the National Defense Science, Technology, and Industry Commission.

PHOTO: A/P WIDE WORLD

Strategic weapons, such as the nuclear missiles already deployed, are China's number-one military priority.

In an important policy statement in 1983 that received limited attention in the West, Zhang announced that strategic nuclear weapons would be China's number-one defense priority. The Chinese are most in need of the underlying "building-block" technologies for such weapons—microelectronics, special metals, and advanced materials. Writing in *Red Flag*, Zhang conceded that the Chinese might not be able to purchase the most advanced technologies in such areas from the West, and he encouraged greater self-reliance in developing them. But he also urged defense personnel to use foreign technology whenever possible.

Thus, it appears that Chinese insistence on receiving more advanced U.S. technology has stemmed in good part from military pressures. Zhang has said that military uses are a top priority in the electronics industry, and even Jiang Zemin, minister of the Electronics Industry, has emphasized the need for building up the military's electronics technology. Of course, improved computers are also critical for the civilian sector's ability to progress as well as to assimilate foreign technologies. However, as China develops advanced computers and integrated circuits, they will be used to contribute to the military as well.

To Export or Not to Export

Prior to 1983 the United States was cautious about giving the Chinese military technologies. According to the so-called "China differential," established when the Soviets invaded Afghanistan, China could be sold technology at two times the level of sophistication of that sold to the Soviet Union prior to the invasion. This was an inexact measure in all respects except perhaps political intent.

During the Carter and Reagan administrations, China pressed the United States to move forward as rapidly as possible in lifting restrictions on the sale of advanced technology. A surge of such pressure began in October 1982 when former Foreign Minister Huang Hua, speaking before the Council on Foreign Relations in New York, claimed that the United States continued to discriminate in the level of technology exported to China. Huang charged the United States with a lack of sincerity in its commitment to the Sino-American relationship. Throughout that year, whenever U.S. officials and scientists visited China, their hosts pressed them on this issue.

For their part, U.S. officials conceded that they might have been delinquent regarding some promises to sell technology. For example, the shipment of several powerful IBM computers for China's census was delayed. It appears that a coterie of American officials traveling to China had intimated to Chinese leaders that the U.S. government would be more generous in relaxing export controls than was in fact possible. As a result, Chinese expectations went unfulfilled. However, a substantial amount of U.S. technology was in fact flowing to China during this period, and according to the U.S. Department of Commerce, many of the Chinese complaints were unwarranted. The Chinese were to some extent posturing. Nevertheless, U.S. officials were sensitive to this issue and concerned that, with Sino-Soviet talks going on, the relationship between the United States and China might be souring.

Also, many observers ignored China's own trouble deciding what it wanted to buy and instead blamed U.S. regulations for the unfulfilled promise of the China trade. The National Council for U.S.-China Trade, a business group, believed that sales were being lost because of tight export controls and pressured the government to relax them.

As a result, the United States issued new regulations in mid-1983 that reclassified China from the "P" category, which had been specially created for that country, to the "V" category, which includes most U.S. allies and friendly nonaligned countries. Technology transfers can be denied if they would demonstrably contribute to the six so-called "special mission areas": nuclear weapons, nuclear delivery systems such as ICBMs, antisubmarine warfare, electronic warfare, intelligence gathering, and power-projection capabilities such as long-range bombers. In effect, advanced military technologies are not to be exported. However, many of the building-block technologies that the Chinese need for military purposes, such as advanced materials and electronics, can be exported. And as I noted, 75 percent of the technology that the Chinese request from the United States is related to electronics and computers.

When China has been unable to obtain technologies that it desires legally, it has apparently been willing to turn to clandestine means. Lieutenant General James A. Williams, director of the Defense Intelligence Agency, said at a congressional hearing in

The translation of Alvin Toffler's *The Third Wave* caused quite a stir among China's leaders about acquiring state-of-the-art technologies.

the summer of 1982 that China had begun to set up dummy firms to bypass export controls. Such firms operate in the United States but employ Chinese nationals who learn about new technologies and return home with their knowledge. An article in the *International Herald Tribune* in January 1984 reported a steady rise in Chinese investment in the United States and Canada, possibly designed to gain access to restricted technologies, among other purposes. If pressured by their military, the Chinese might step up such clandestine activities and apply political leverage to liberalize export controls further.

Of course, the Chinese would have to do considerable research and development to build weapons using these technologies. But considering the overlap between the military and civilian sectors, as well as China's refusal to accept restrictions on the use of imported technologies, policymakers must assume that the Chinese will try to incorporate civilian technologies in weapons. I do not believe the United States has adequately weighed these risks.

A Considered Policy

The U.S. government ultimately needs to define its goals regarding the Sino-American relationship more clearly. China will continue to follow an independent course in foreign policy; Americans should not expect anything else, in light of China's need to follow its own national interest. Yet Chinese leaders should make a firmer commitment to forging an understanding with the United States. They should consult more frequently on international issues and be more sensitive to the complexities of U.S. foreign policy. They should cooperate more fully on matters such as preventing nuclear proliferation and conforming to U.S. export controls. In fact, the United States should demand the same respect and mutual benefit that China seeks in its relations with foreign nations.

I believe the United States should carefully monitor and control the export of advanced military technologies. However, given a stronger political relationship, the United States should also continue to integrate China into the world economy and scientific community. In particular, it is important to build a stronger Sino-U.S. relationship in exchanging scientific information and intermediate civilian technologies. For example, a good program is the one sponsored by the U.S. National Academy of Sciences and China's State Science and Technology Commission, aimed at forging closer links between Chinese research and industry.

The objectives I propose may not be easy to implement and will raise many critical questions. To help modernize Chinese civilian industry while restricting advances in strategic arms, U.S. policymakers need to understand better how China targets technologies for import and what its capacity is to assimilate these technologies. Important untapped sources of information are U.S., Western European, and Japanese corporations doing business with China.

In transferring civilian technologies—even intermediate ones—the United States should consider that when Chinese industries such as textiles, machinery, and electronics increase their exports, they could pose a competitive threat, much as Japanese industries have. No one in Washington has studied the long-term ramifications of this issue. Both commercial competition and China's military potential are of particular concern to other East Asian countries, including Malaysia and Indonesia.

The U.S. government should pay more attention to competition among American, Western European, and Japanese firms for commercial sales to China. Although U.S. firms are improving their sales, Japan has probably been more successful in establishing mutually beneficial relations with Chinese civilian industries. Japanese firms have shifted away from supplying entire plants and are working with the Chinese to improve plant management and layout and to install selected pieces of equipment. Japanese governmental agencies advise domestic firms of business opportunities in China. U.S. agencies that have contact with China (through the management center in Dalian, for example) should seek a more direct way to do the same for American companies.

In considering the transfer of technologies with military potential, policymakers should bear in mind China's domestic industrial reforms, its large number of cooperative science and technology agreements with the West, and its increasingly educated technical personnel. These signs of substantial progress suggest that the Chinese will be able to move further and faster than many Westerners believe in improving high-priority military technologies. The liberal 1983 U.S. export guidelines are premised on a rather static view of China's science and technol-

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The liberal U.S. guidelines on exports to China could lead to a technological surprise.

ogy capabilities, and they leave open the potential for a technological surprise in the future.

The United States must seek to strengthen the Coordinating Committee on Export Controls (COCOM), a multinational body composed of NATO members (except for Iceland) and Japan that is responsible for controlling exports of critical technologies to Communist countries. Several COCOM members tend to be freer with advanced technologies than is the United States. Also, when the United States questions a potential sale through COCOM, other members sometimes suspect that the aim is to hold up the sale while tipping off U.S. companies. The United States needs to address these problems and monitor better the technology flowing into China from other nations. Otherwise, given the availability of technology from many advanced nations, any further Chinese pressures to loosen export controls could be hard to withstand.

The approach I am suggesting is in many ways best for China as well as the United States. Even in the nineteenth century the Chinese were overzealous in trying to acquire state-of-the-art foreign technologies, and today their political fear of falling far behind is just that: a political fear that could actually impair their ability to build up basic industries. In the civilian sector, China does not need to make a great leap forward but to assimilate intermediate technologies. These are what the United States should provide. This approach will help to build an economically strong China, motivate its government to behave responsibly in foreign affairs, and shape, however modestly, emerging Chinese attitudes.

DENIS FRED SIMON, Ford International Assistant Professor of Management at M.I.T., has written extensively on China's science and technology policies. He is currently preparing an assessment of China's ability to assimilate foreign technology for the Joint Economic Committee of the U.S. Congress.

Learn to Manage Technology at MIT

At MIT the Sloan School of Management and the School of Engineering are jointly teaching engineers and scientists how to manage technology to help bridge the gap often found between technologist and manager in today's technology-based organization.

The MIT Management of Technology Program is designed for experienced technical professionals who are on a career path of increasing managerial responsibility for technical activities. The Program entails 12 months of full-time study beginning in June of each year. After completion the following June, the Master of Science in the Management of Technology is awarded.

Intensive study of managerial aspects of technical activities is the base of the Program's curriculum, drawn from 20 years of ongoing research at MIT in the area of management of research, development, engineering, and technology-based innovation. The Program goes far beyond the standard MBA type of curriculum in addressing the specific questions and issues faced by the technical manager in today's organization.

Applications are due February 1. Engineers and scientists with at least 5 years of work experience are encouraged to apply.

For more information and application material please contact Jane M. Morse, Program Manager, Management of Technology Program, Room E52-125, Massachusetts Institute of Technology Cambridge, MA 02139 (617-253-3733).

Robotic Control Language

IBM

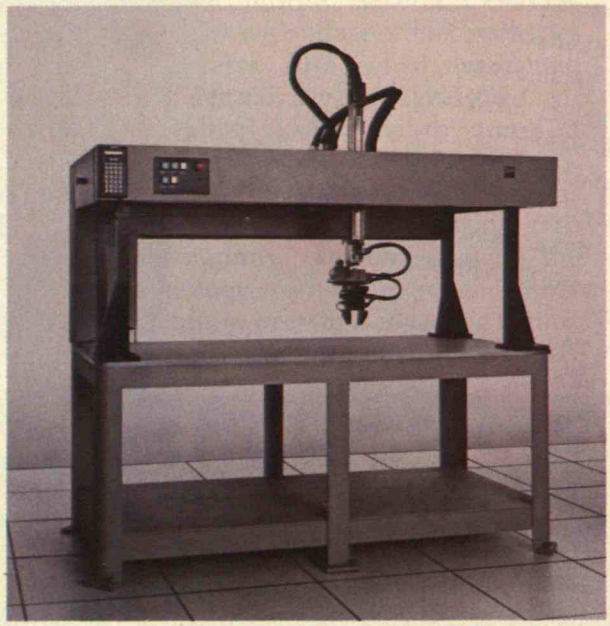
To: Jeanine
From: Bill
Subject: IBM Technology

I've been reviewing some of our past and present technological achievements, and it occurred to me that the scientific, engineering, and academic communities might like to know more about them. Will you select a topic from the following list? Thanks.

Vacuum tube digital multiplier
IBM 603/604 calculators
Selective Sequence Electronic Calculator (SSEC)
Tape drive vacuum column
Naval Ordnance Research Calculator (NORC)
Input/output channel
IBM 608 transistor calculator
FORTRAN
RAMAC and disks
First automated transistor production
Chain and train printers
Input/Output Control System (IOCS)
STRETCH computer
"Selectric" typewriter
SABRE airline reservation system
Removable disk pack
Virtual machine concept
Hypertape
System/360 compatible family
Operating System/360
Solid Logic Technology
System/360 Model 67/Time-Sharing System
One-transistor memory cell
Cache memory
Relational data base
First all-monolithic main memory
Thin-film recording head
Floppy disk
Tape group code recording
Systems Network Architecture
Federal cryptographic standard
Laser/electrophotographic printer
First 64K-bit chip mass production
First E-beam direct-write chip production
Thermal Conduction Module
288K-bit memory chip
Robotic control language

Bill—
Our robotic control language is an important factor in programmable automation. It's a terrific story—let's go with it.
Jeanine

Figure 1. *IBM's robotic control language, AML (A Manufacturing Language), is used in all robotic systems that IBM markets. Shown here is the high-end product, the IBM 7565 Manufacturing System, which represents leading-edge technology in intelligent robotics for complex assembly. This system is controlled by an IBM Series/1 computer that monitors manipulator position and sensory feedback 50 times per second, making real-time adjustments if necessary. IBM's mid-range products use AML/Entry, a simplified version of AML, enabling them to be programmed with IBM Personal Computers.*



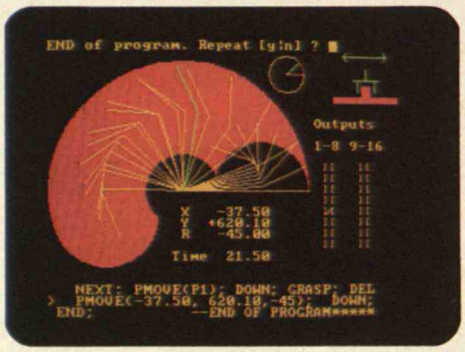


Figure 2. *This display from the AML/Entry Application Simulator is used to check the logic and efficiency of an AML/Entry program, display the robotic arm manipulation (from above), and provide timing estimates.*

Manufacturers everywhere face increasing pressure to produce products of higher quality at lower costs. Today, programmable robotic systems, with their ability to adapt to diverse manufacturing environments, are tools that help meet this challenge.

More than a decade ago, when IBM researchers began investigating flexible automation, they noted that control of manipulation was only one aspect of successful robotic applications; related tasks included terminal and storage input and output, communications, and computation. To integrate all these tasks, they designed a new general-purpose computer language and extended it with functions needed to control a robotic system.

The language that evolved, AML (A Manufacturing Language), is the most advanced robotic control language commercially available today.

In addition to robotic commands such as MOVE, SPEED, and MONITOR—which control motions through sensory feedback—AML has a wide range of communications and data processing capabilities.

AML is able to support different levels of user sophistication because of its structure: a powerful base language designed for functional enhancement through subroutines and application packages. For example, the GRASP subroutine found in many assembly applications is written in AML but is used exactly as if it were a primitive command. Experienced programmers can combine the existing base commands to construct higher-level routines.

AML is an interactive language. It provides the user with the ability to stop a program, check the logical and physical status of the system, change the program, and continue execution. This is critical for efficient development of robotic applications, which must deal with the variability of the real world.

AML has proved to be well adapted for implementing a wide variety of operator inter-

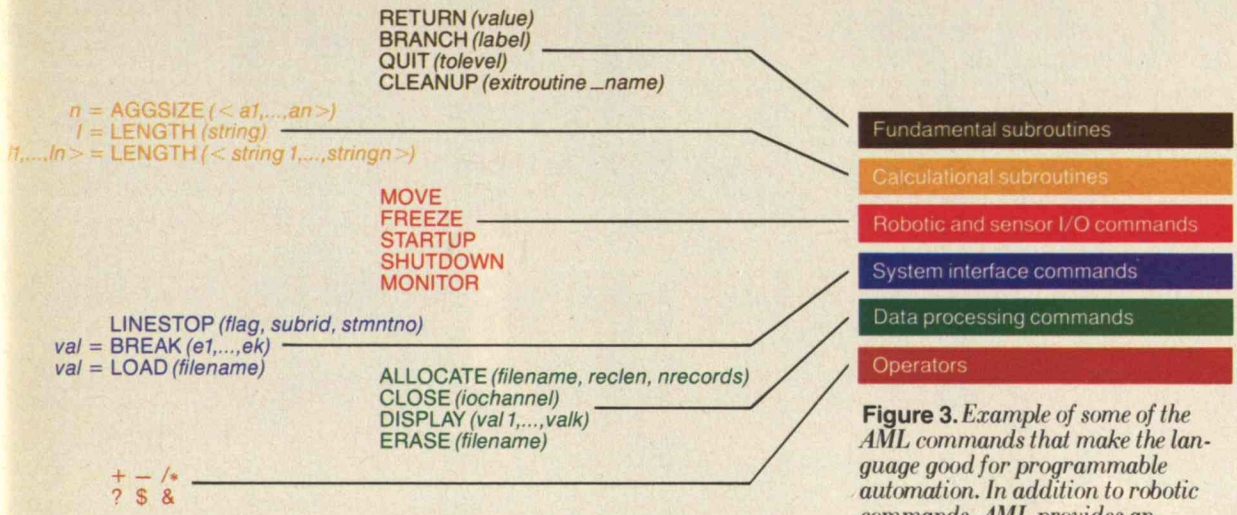


Figure 3. *Example of some of the AML commands that make the language good for programmable automation. In addition to robotic commands, AML provides an abundance of communications and data processing commands.*

faces, including a menu-driven display screen and the common "guiding through the motions" method. In the latter, the operator moves the manipulator through the steps of a task by using a hand-held, push-button pendant. After the operator completes the steps, the system automatically writes an efficient program in AML.

IBM uses its own robotic technology. For instance, IBM is working on computer-integrated manufacturing of typewriters: more than 250 robotic units will put together most of the typewriter subassemblies in an automated plant the size of two football fields. In other sites throughout the world, IBM robotic systems are used in such applications as testing circuits, producing cables, and assembling printer type chains.

Many IBM scientists, engineers, and programmers contributed to the development of the innovative robotic control language, AML. Their contributions are only part of IBM's continuing commitment to research, development, and engineering.

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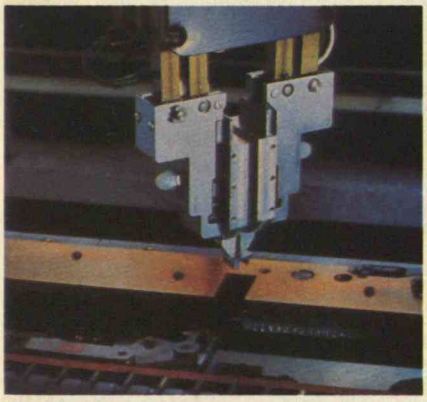


Figure 4. *In the automatic assembly of type chains for an IBM high-speed printer—one of the many examples of IBM robotic systems at work within the company—an AML program is used to consult a data base to determine the correct sequence of type slugs. This application makes extensive use of sensing and programmed error recovery to ensure high reliability.*

```
Step_1:
  CMOVE (<feeder_app(fdr),        --Move to
          feeder_orient, .5>);      grasping
                                    position

  IF DCMOVE (<<0,0,-.75>>,
             ANY_FORCE (2*OZS),
             <.5>) THEN
    BEGIN                         --Hit something
                                    on way in
    DCMOVE (<<0,0,2>>);           --Back out
    OP_CHECK ('jammed');          --Notify
    END;                            operator
Step_2:
  cc = GRASP (0.1,                --Attempt to
              <-.04, .04>,          grasp slug
              PINCH_FORCE (1*LBS));
```

Figure 5. *This is an excerpt of AML code from the program for the application shown in Figure 4. It directs the gripper to open 0.5 inches while approaching a feeder for the next slug of type. It then moves the gripper to the grasping position and grasps the slug with a gripping force of one pound. If an unexpected force is encountered while approaching the feeder, appropriate error-recovery actions are taken.*

Tacoma, Wash., recently served as a proving ground for the Environmental Protection Agency's new strategy of involving the public in managing environmental and health hazards. The verdict: a qualified success.

Environmental Risk: Power to the People

BY BARNETT N. KALIKOW

On June 29, 1984, Asarco, a major U.S. metals producer, announced that it would shut down its copper smelting operations in Tacoma, Wash., by June 1985. Some 500 persons will lose their jobs at the plant, which has operated at the site since 1890, and which Asarco has owned since 1905. Asarco's stated reasons for closing the smelter include falling world copper prices and the need to install a $150 million furnace to meet the state's sulfur dioxide emission standard. The standard has been on the books since 1970, and the company's final variance from compliance was due to expire.

For Tacoma, Asarco's announcement renders essentially moot the U.S. Environmental Protection Agency's long-running regulatory effort to control the amount of arsenic, a known cancer-causing agent in humans, emitted by the smelter. In the larger context, however, EPA considers Tacoma a proving ground for the agency's new strategy of involving the public more closely in managing environmental and health risks. What follows is the story of the Tacoma experiment and a look at whether, and how, the EPA can spread its new gospel of public involvement.

TACOMA, Wash., has always been known as a solid lunch-pail town. Its major industries—smelting, shipbuilding, wood products—have poured the American foundation. But Tacoma is also a town in transition, struggling to diversify its industrial and mercantile base and to transform the downtown area from a picture of 1970s urban decay into a model of 1980s commercial culture.

The city is largely succeeding in its image change. The Pantages Theater Center was dedicated two years ago, the new Tacoma Dome has attracted concerts and a sports franchise away from big sister Seattle, and the Broadway Mall's upscale shops and restaurants are opening one by one. Indeed, Tacoma was recently voted an "all-American city" by the League of Women Voters, The Municipal League, and the Association of City Managers. Mayor Douglas Sutherland and the Economic Development Board are spreading the word that Tacoma is a land of natural beauty and high-tech opportunity. Their pitch has attracted such companies as Fairchild Camera and Nippon Electric.

But Tacoma, like many other cities, hasn't totally escaped the legacy of its industrial past. Old chemical dumping grounds are beginning to infuse local wells, according to almost weekly news accounts. The EPA has named Commencement Bay, on which the Port of Tacoma is located, as one of the nation's most polluted waterways. And the Asarco copper smelter, recently thrust into the national spotlight, has the dubious distinction of being the worst arsenic polluter in the United States.

Arsenic is known to mystery-novel fans as a quick and dramatic poison in relatively high doses. But the major environmental concern is that exposure to lower levels of the element causes skin and lung cancer in humans.

Ironically, the copper smelter's uniquely high arsenic emissions result partly because the plant also produces arsenic as a commercial byproduct. Present as a contaminant in the copper ore, the arsenic is extracted during smelting and sold to industries that produce goods ranging from pesticides and wood products to glass and electronics. Indeed, the Tacoma plant is the nation's only producer of industrial arsenic, supplying roughly one-third of the metalloid used in the United States. Thus, the smelter seeks out copper ore with a much higher arsenic content than other smelters use, importing most of its ore from the Philippines. Arsenic makes up about four percent of the ore smelted at Tacoma; no other smelter uses ore with more than 0.6 percent arsenic.

Asarco's smelter was built decades before environmental concern became part of public law, which adds to its emission problem. Smelter manager Larry Lindquist freely admits that arsenic released from the ore during processing is not captured as carefully as would be the case in a plant built today.

Federal, state, and local agencies have tried for years to reduce the smelter's emission of arsenic, as well as sulfur dioxide and other pollutants. The Puget Sound Air Pollution Control Authority (PSAPCA), a regulatory arm of the state, has cited the company hundreds of times and assessed fines for violating air-quality standards. But the fines amount to no more than "pocket money" for Asarco, says Henry Lee, executive director of Harvard University's Energy and Environmental Policy Center, who has studied the smelter. "The company has by and large resisted compliance all down the line, usually preferring to pay small fines until forced to take action," declares Lee.

There has been progress, slow but steady. Smelter manager Lindquist says Asarco has spent tens of millions of dollars on devices to control arsenic emissions. These include electrostatic precipitators that remove arsenic particles from exhaust gases and a pneumatic system for moving materials around the plant without exposing them to the air. And after years of negotiation with PSAPCA and the EPA,

Opposite: Asarco's smelter sits cheek by jowl with Tacoma homes.

PHOTO: PHILIP AMDAL, WEST STOCK

Some people criticized the EPA for passing the regulatory buck and unnecessarily endangering their lives.

Protestors at public hearings leveled charges of "economic blackmail."

company officials finally agreed to install hoods on the plant's four converters. These are the furnaces that purify the molten copper, the last of three steps in the smelting process. The hoods would capture "fugitive" arsenic emissions—that is, emissions not collected by control equipment and vented up the 571-foot smokestack. The EPA says fugitive emissions "pose the greatest risk to public health because they are released closer to ground level and have less chance of dispersing before reaching the public."

Regulatory Slow-Motion

That was the scene in Tacoma in January 1983, when the arsenic-regulation plot began to thicken. The story switches to New York City, where a federal district judge ruled on a suit filed against the EPA. New York State, concerned about arsenic blowing in from a glassmaking plant in New Jersey, was trying to force the EPA to live up to requirements of the Clean Air Act.

In 1980, the EPA had branded arsenic a "hazardous air pollutant." The act allowed the EPA 180 days to publish a proposed regulation and then another 180 days to issue its final standard. But EPA had missed the deadline, and New York was trying to force the agency's hand. The judge, in a strongly worded opinion, agreed with New York and set July 11, 1983, as EPA's new deadline for proposing its final standard. EPA succeeded, publishing proposed standards in the *Federal Register* for three types of industrial sources: "high-arsenic-throughput" copper smelters, "low-arsenic-throughput" copper smelters, and glassmaking plants. The smelter in Tacoma is the only "high-arsenic" smelter in the country and no others are likely to be built.

In setting its standards, the Clean Air Act requires EPA to "provide an ample margin of safety to protect the public health." However, EPA stated in the *Federal Register* that it "takes the position, shared by other federal regulatory agencies, that carcinogens should be considered to pose some cancer risk at any exposure level. This 'nonthreshold' presumption is based on the view that as little as one molecule of a carcinogenic substance may be sufficient to transform a normal cell into a cancer cell."

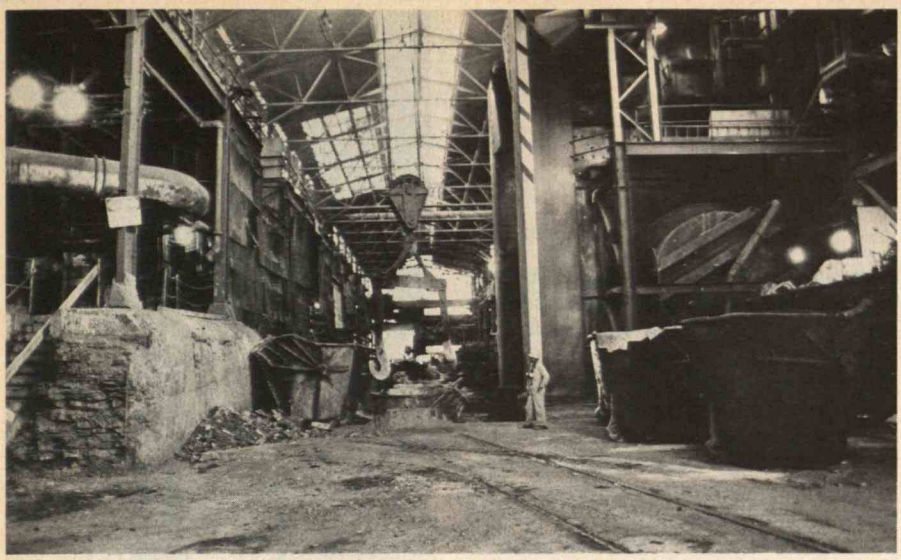
However, the EPA continued, neither the language nor the history of the act "reveals any specific Congressional intent on how to apply the phrase 'provide an ample margin of safety to protect the public health' to nonthreshold pollutants." Thus, ensuring total safety could conceivably require eliminating all emissions, which the EPA said might often shut down the plants being regulated. Since wholesale closure of industries "didn't appear to be the intent of Congress," the EPA said it must take another approach to regulating nonthreshold carcinogens—requiring plants to control the pollutants "at least to the level that reflects best available technology (BAT), and to a more stringent level if, in the judgment of EPA's administrator, it is necessary to prevent unreasonable risk."

By BAT, the agency means "the best controls available, considering economic, energy, and environmental impacts." For the Asarco smelter, the EPA proposed that the hoods the company had agreed to install on its converters filled the bill. The agency estimated that installing the hoods would cost $3.5 million and annual operating costs would run $1.5 million, concluding that the controls "could increase the price of copper by about 0.8 percent, if the company chose to maintain its normal profit margin." EPA said that Asarco had already taken adequate steps to reduce arsenic emissions from other parts of the smelting operation. And it argued that the cost of additional control measures would likely put the smelter out of business.

The EPA also announced a radically new plan: The agency would actively seek comments about the proposed regulation from people living near the Tacoma smelter. The Clean Air Act requires a period for public comment, but hearings are usually announced in the back pages of newspapers and go largely unattended. This was to be different. The architect of the new strategy was William D. Ruckelshaus, the agency's first administrator, who had returned to the helm after Anne Gorsuch Burford resigned amidst considerable controversy. From the time he returned, Ruckelshaus stated that regulating environmental risks should include balancing costs and benefits and that the people most directly affected should have a say in how to control risks, at what price, and at what pace (*See "Risk: The View from the Top," page 58*). "For me to sit here in Washington and tell the people of Tacoma what is an acceptable risk would be at best arrogant and at worst inexcusable," Ruckelshaus said in announcing the agency's intentions.

Ruckelshaus was familiar with the situation in Tacoma. Prior to returning to EPA, he was president of Weyerhaeuser, the forest-products giant whose headquarters are in the Tacoma area. South Puget Sound has been his family's home for many years. Ruckelshaus knew, for example, that Asarco employs 550 people, owns a large tract in the center of what is now a residential district, spends about $49 million annually for wages, benefits, fuel, and services, and adds about $2.2 million to state and local tax rolls. Most of that would be lost if the smelter closed,

PHOTO: BRUCE LARSON, TACOMA NEWS TRIBUNE



Asarco claimed smelter emissions were not a public health problem.

Asarco's century-old copper smelter is the nation's worst emitter of arsenic, a known cancer-causing agent in humans.

a devastating blow to an area whose other major industries have not yet recovered from recession.

"In making his announcement, Ruckelshaus tossed a complex problem onto the lap of EPA's staff," says Harvard's Henry Lee. "What sounded very good in theory would be difficult to implement in practice. There was no proven model of how to present these trade-offs to the public, since the use of risk analysis had heretofore been limited to the world of experts."

Responsibility fell largely on EPA's Northwest regional office in Seattle. Its staff decided to proceed in two steps: The agency would first hold a series of public workshops to inform people about the details of the proposal, and later hold public hearings. Everything would be well publicized, and the agency would actively seek participation from community organizations ranging from environmental and citizen-action groups to Asarco's management and the union.

The Public Speaks Out

Ernesta Barnes, EPA's regional administrator, announced the goal: "EPA is openly acknowledging that our proposed controls for Asarco will not eliminate risks to health, but will only reduce them. The question facing citizens is whether the reduced health risk is reasonable. During the upcoming public comment period, EPA is encouraging people within a 12.5 mile radius of the smelter to help decide what is an 'acceptable' or 'reasonable' health risk. In addition, EPA will be soliciting the comments of knowledgeable parties—Asarco officials and employees, the engineering community, state and local air pollution control agencies—who are in the best position to tell EPA whether our proposal does, indeed, represent the best available control technology." She also stressed that Ruckelshaus would make the final decision—there would be no vote—but that he planned to weigh the public comments heavily.

The workshops were held in August and the public hearings in November of 1983. They were well attended and discussion was often spirited. Some groups criticized EPA for shirking its responsibility and passing the regulatory buck; others charged that the agency was unfairly casting the issue as jobs versus health. But many of the participants focused on the specifics of EPA's proposed regulations.

For example, there were quarrels over the agency's cancer statistics. The EPA used an "absolute risk" model to calculate the added risk of getting cancer from exposure to arsenic. This model assumes a linear relationship between exposure and risk. In other words, as EPA explained in a fact sheet handed out at meetings, "a person who inhales one microgram of arsenic per cubic meter of air is one-tenth as likely to get cancer as a person who inhales ten micrograms per cubic meter." EPA scientists initially calculated that there was the *possibility* of four extra cancer deaths a year from arsenic exposure without the proposed emission-control hoods and two extra deaths with the hoods. The agency later lowered its estimates to the possibility of two deaths without the hoods and one death with the hoods in place.

But Asarco scientists claimed that there is in fact a threshold below which there is no cancer risk, and that the threshold is many times higher than present exposure levels in the community. They cited recent studies by state scientists and others that found no excess deaths from lung cancer among people living in Tacoma and surrounding Pierce County. In fact, there are slightly fewer deaths from lung cancer here than the overall national average.

While not agreeing with Asarco's claims for a threshold, Sam Milham, senior epidemiologist with the State Department of Vital Statistics, also disputed the EPA's estimates. Milham conducted many of the pioneering studies on arsenic's link with cancer. He said current evidence suggests that the cancer risk rises as exposure increases, but then levels off. For example, he found that smelter workers were all about twice as likely as the general public to get lung cancer, no matter whether they worked in low-exposure or high-exposure areas of the plant. Thus, Milham concluded, even EPA's revised estimates were probably too high.

EPA's estimates of how much arsenic the smelter actually emits drew even more severe fire. Rather than undertake expensive and time-consuming monitoring, the agency relied on a computer model to predict the dispersion of emissions. But the model's imperfections were glaring—for example, it assumed the smelter is on flat land, while in fact it is tucked into the side of a steep hill—and its predictions were roundly criticized. Asarco scientists, who had monitored the air around the smelter for years, quoted their statistics. "These actual data, which Asarco routinely submits to local air-pollution control agencies, show that EPA's model overpredicts maximum ambient concentrations of arsenic by a factor of 10," according to company chairman Ralph Hennebach.

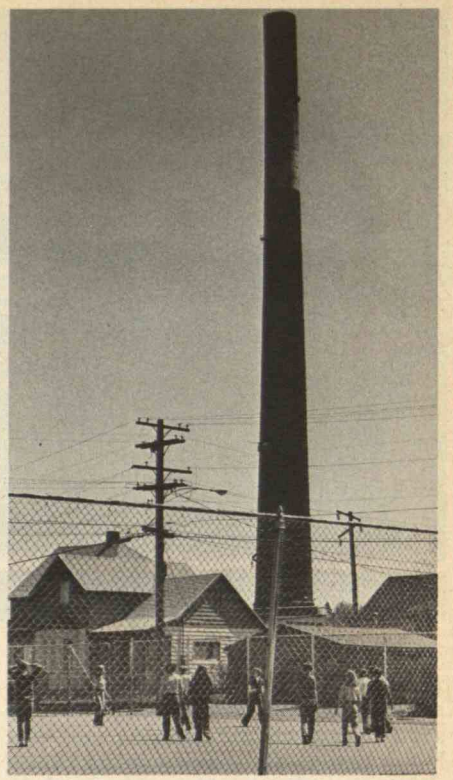
EPA scientists eventually revised their model, collected data from the smelter and the community, and changed the estimates. Ernesta Barnes characterized the new emission data as "good news and bad news." The good news, she said, "is that the emissions of arsenic from the smelter's main stack are much less than originally estimated. It's also good news that the

PHOTO: NATALIE FOBES, SEATTLE TIMES

control equipment EPA has proposed will bring down—from 58 tons a year to 26 tons a year—the amount of arsenic released as fugitive emissions from the smelter. But the bad news is that the amount of fugitive emissions released near ground level from other sources is greater than we originally estimated."

EPA also met strong resistance to its claim that installation of converter hoods was all that was needed and economically appropriate. Harvey Poll of the Puget Sound Air Pollution Control Agency testified that requiring hoods "is good but insufficient." He wanted EPA to include his agency's order that the smelter reduce its sulfur dioxide emissions by 90 percent, since the control equipment would also cut arsenic emissions. Asarco had largely ignored PSAPCA's order, and Poll said incorporating it into federal law would improve the company's compliance. Nearly all the environmental groups supported this proposal. PSAPCA proposed another step that gained popular support as well—setting an "action level" for ambient arsenic levels in the community. When monitors determined that arsenic levels were too high, the plant would be required to curtail operations.

The Tahomans for a Healthy Environment—Tahoma is the Indian name for Mt. Rainier, from which the city took its name—questioned EPA's use of information from Asarco in determining what technology the company could or could not afford. "This places the regulation of a carcinogen in the hands of corporate accountants," the group maintained. "This is not to say that the smelter may not be in some economic jeopardy or that Asarco is using deceptive accounting practices. But with Asarco providing the economic data, it is unlikely that the EPA or the public could accurately determine what the company could afford and it may not



Children living nearby have high levels of arsenic in their bodies.

Risk: The View from the Top

BY WILLIAM D. RUCKELSHAUS

THE progress we made during the 1970s in improving environmental quality has not been matched by an equivalent improvement in our ability to confidently assess risk. Thus, many Americans are now more worried about the environmental risks they face than they were a decade ago, when overall risk was clearly greater.

There is no escaping risk in modern society. But it is time to realize that we can do a far better job of determining what constitutes an acceptable risk in various situations, especially in view of the awesome social and economic consequences of many of our decisions. We must replace the hodge-podge of inconsistent standards and regulations with a more predictable and harmonious approach that permits us to keep problems in perspective and forces us to see the whole picture.

The Environmental Protection Agency (EPA) is studying ways to make it easier for the public to understand how decisions are made, establish more consistent standards for assessing a broad range of environmental and public health risks, and enable us to handle the ever more sophisticated and subtle findings of science. Our approach will not be a screen behind which we will try to ease existing environmental standards—the goal is still to reduce pollution drastically. But every decision should be made in a common framework using the same methodology. At the same time, our improved skills in analyzing risk will allow each decision to be made on its own merits. Precedents are always important, but each case is in some respect unique. In short, we need to develop both a more uniform process and a more customized "product."

The first step in laying the foundation for a new understanding of how to handle risk is to agree on a set of principles that should guide the efforts of government, industry, and the public. In my judgment, the major principles are these:

☐ There is a distinct difference between the scientific process of risk *assessment* and the political process of risk *management*. Risk assessment is the untrammeled scientific effort to examine the effects that various substances are likely to have on the human body and the environment. We can then make decisions about what to do—about how to manage the risks that science has described. We can decide just what we are willing to do, at what pace, and at what price.

☐ We need to develop a consensus on methods for evaluating risk. Further, we must search for ways of describing risk in terms that the average citizen can understand. Telling a family living close to a manufacturing facility that no further controls are needed on the plant's emissions because, according to our linear model, their risk of getting cancer is only 10^{-6} is not very reassuring. We need to describe suspect substances as clearly as possible, describe the known or suspected health problems (including the inherent uncertainties and

PHOTO: RUSS CARMACK, TACOMA NEWS TRIBUNE

People directly affected by environmental hazards should have a say in how to control the risks, at what price, and at what pace.

be in the company's best interest to assist the agency in doing so."

When the hearings ended, the spotlight shifted to EPA's laboratories in North Carolina, where scientists set about trying to improve the computer model and refine exposure and risk estimates. And at EPA headquarters in Washington, the hope was to issue a final regulation for all industrial sources of arsenic by summer of 1984. But in June, Asarco announced its plans to close the smelter. Armand L. Labbe, corporate vice president, called the smelter a "victim of depressed copper prices, a shortage of copper concentrates that could be processed profitably, and federal, state, and local environmental regulations." Asarco was at last facing the necessity of installing a new $150 million furnace to meet PSAPCA's sulfur dioxide standard, which the company had long avoided, according to its critics, by legal maneuvering. "Investments of that magnitude cannot be justified under present market conditions at the Tacoma plant, which has been operating at a loss for the past five years," Labbe said.

However, Asarco plans to continue operating the commercial arsenic plant. This will provide jobs for about 50 of the 550 workers now employed. According to Curtis Dungey, senior environmental scientist at Asarco, the source of arsenic will no longer be copper ore. Rather, the plant will process metal byproducts from two of Asarco's lead smelters, since lead ore also contains some arsenic. And the company is now testing a pilot plant that uses chemical leaching rather than furnaces to obtain the arsenic. This system, Dungey says, "should release little or no arsenic into the environment."

All this leaves EPA's regulatory proposals for the Tacoma plant up in the air. "The agency is nearing a decision about just what kind of regulation to issue," says Robert Ajax, chief of EPA's standards development branch in Research Triangle Park, N.C. "However, it doesn't seem to make much sense to go ahead with a standard aimed specifically at a plant that doesn't exist any more."

One option being considered is to drop the distinction between the Tacoma plant and other copper smelters, issuing a regulatory standard for "generic" smelters. The standard would be written to include high-arsenic smelters if any were to be built. Indeed, the "best available technology" proposed for the Tacoma smelter is the same as that proposed for other smelters; the Tacoma standard simply dotted every "i" and crossed every "t" with the smelter's unusual emission levels in mind. Ajax says the EPA also must decide what to do about the arsenic plant that Asarco will maintain: "Arsenic plants" may have to be included as another category in the final standard. He says the standard

complexities), and help people compare that risk to other everyday dangers such as driving or smoking.

☐ We need better methods for evaluating the costs and benefits of pollution-control efforts. This includes complex societal costs that are often overlooked but that are ultimately paid by taxpayers or other "innocent" parties. On the other hand, reducing pollution provides many gains that have been largely ignored. For example, studies report that the economic benefits of controlling air pollution range from $4.6 billion to $51.2 billion annually.

☐ The best judges of society's willingness to assume risks associated with certain decisions are the people most directly affected. The public, therefore, must be involved in decisionmaking and have meaningful access to decisionmakers.

☐ The government must regain and then sustain the public's trust as an arbiter that is partial to the public's rights, that is efficient and timely in its decisionmaking, that fairly balances the benefits and risks associated with various courses of action, and that strictly and fairly enforces the law. Its decisions must be arrived at openly.

☐ The public needs to accept the inevitability of some risk and uncertainty in nearly every decision and action, despite good-faith efforts to minimize people's exposure to local and long-distance environmental contaminants.

The EPA is developing a comprehensive program to address these principles. We have formed a government-wide task force—composed of representatives from the major agencies that regulate health and the environment—to review existing methods of evaluating risk. I have asked the EPA staff to examine the various methods used by the agency to evaluate risk, and to strictly differentiate between risk assessment and management. And I have taken steps to reinvigorate EPA's R&D program on risk assessment and to encourage disciplined peer review.

We are also studying public educational programs that can be integrated into the decisionmaking process. Indeed, we used some of these ideas in the case of the Asarco copper smelter in Tacoma, Wash., and will continue using and evaluating outreach programs in considering other problems such as acid rain. Finally, we are looking at ways to encourage industries to incorporate our proposed approach to risk assessment and management in their own long-range planning processes.

Lest anyone misunderstand, I am not suggesting that all the elements of managing risk can be reduced to some neat mathematical formula. However, using a disciplined approach will help us organize our thoughts to include all the elements that should be weighed. And it is clear to me that we must consider the perceptions of the public when we make decisions, though it's just as clear that this hasn't always been the case. Instead of objective and subjective risks, the experts sometimes substitute "real" and "imaginary" risks. There is a certain arrogance in this—an elitism that has ill served us in the past.

As Thomas Jefferson observed: "If we think [the people] not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion." ☐

WILLIAM D. RUCKELSHAUS is administrator of the U.S. Environmental Protection Agency. This article was adapted from recent articles and speeches by Mr. Ruckelshaus.

Five hundred workers will lose their jobs when the smelter closes, a devastating economic blow to the community.

"The smelter's been good to me," said Ron Belton on hearing about closure.

should be ready early next year.

But even after the smelter closes, significant amounts of arsenic, representing years of accumulation, will remain in the community. Does it present a hazard? With nearly $1 million from the Superfund, a large cash reserve earmarked by Congress to clean up hazardous materials, researchers at the University of Washington are beginning to investigate how arsenic finds its way into peoples' bodies. They know that children living near the smelter have levels of arsenic in their blood, hair, and urine that are 2 to 4 times higher than normal—though studies also suggest that they are no less healthy than other children. But the researchers want to pinpoint how children take in arsenic. Numerous pathways are suspected: household dust, windblown dust from unpaved lots and roads, consumption of contaminated leafy vegetables, playground soil, and smelter emissions.

The monitoring should be completed by December 1985, says Doug Pierce of the Tacoma-Pierce County Health Department, and the researchers hope to issue a final report about a year later. "The evidence so far suggests that children get the most arsenic from house dust," Pierce notes. Once the pathways are established, the EPA will have a better idea of what clean-up steps are necessary.

Spreading the Gospel

"Living in a technological society is like riding a bucking bronco," William Ruckelshaus is wont to say. "The question is: how do we become better bronco busters? I think a great part of the answer is to bring about a major improvement in the quality of public debate on environmental risk." In a recent speech at Princeton University, he said he felt the Tacoma experience did just that. "Although I suppose some would have been happier continuing in their fond belief that we could provide absolute safety with absolute certainty, and were disturbed by these proceedings, in all I would call it a qualified success," he said. "Those who participated came away with a better understanding of the anatomy of environmental decisions, and local groups were able to come up with technological options that might have increased protection while allowing the plant to remain open." Especially cheering, he said, was the fact that some people came to the early public workshops wear-

PHOTO: BRUCE LARSON, TACOMA NEWS TRIBUNE

ing buttons labeled "JOBS," while others wore "HEALTH" buttons. But soon people were sporting buttons that said "BOTH." "I took that as a good sign that people were attending to the balance between economic realities and environmental protection," he said.

No Villains or Heroes

There is similar enthusiasm for the process—if not for the results—among community members who participated. Ruth F. Weiner, head of the Sierra Club's Cascade Chapter and a chemistry professor at Western Washington University, was one of the most active. And while she was also one of the most critical—offering a detailed 12-point plan citing shortcomings and solutions—she defended EPA's intentions. "There has been some criticism that EPA is giving too much public attention to this process," she declared in her testimony. "This criticism is misplaced and unfounded. The Clean Air Act requires public involvement. And in becoming involved, the public begins to appreciate the difficulty attendant on making regulatory decisions and the inadequacy of simply identifying 'heroes' and 'villains' in environmental protection. It may have been hard work and a headache for all of us, but public involvement is most certainly worth it."

Harvard's Henry Lee, who talked to many of the participants, heard similar responses. Most people, he says, lauded the efforts by EPA's regional office to "share information" and "enter into a dialogue with interested parties." (For the public at large, he says a local survey by Roper Reports found that 68 percent of the people interviewed agreed that EPA was correct in seeking public input, while 27 percent disagreed.) In fact, Lee says the EPA's regional office and its director Ernesta Barnes now enjoy more credibility with environmentalists, industrialists, and the public than ever before.

Still, running extensive public-outreach programs does have some bottom-line drawbacks. "The process proved terrifically costly and time consuming," says Randall Smith of EPA's Seattle office. "We clearly don't have the funds or the staff to tackle such a project every time out of the blocks." "Tacoma shows that we have to prepare ourselves for the other Tacomas," says Ruckelshaus. "Environmental stress falls unevenly across the land and we have a special responsibility to people in communities that suffer more than their share. We are prepared to make the extra effort in those communities."

But success can be measured in smaller ways as well. Smith says he and his colleagues learned numerous lessons that they now apply in going about the agency's more routine business. For example, in mid-August EPA held a public hearing in Kellogg, Idaho, concerning a local lead smelter. "We tried to make the hearing a low-cost, low-key version of Tacoma," Smith says. "Although we only had one meeting to work with, we tried to follow the same pattern."

This meant opening the hearing by explaining the issues and proposals, complete with fact sheets, before beginning public testimony. "People often come to hearings feeling out-gunned by the experts, so they start out already frustrated with the process," he says. "We think we can help overcome that by being as open as possible as soon as possible." Being open also means being clear—terms familiar to bureaucrats and scientists are generally foreign to most members of the public. "That may seem a well-worn observation, but we found that it's a hard habit to break," says Smith. "And unless you do, people often think you are trying to trick them."

For Tacoma, there is perhaps an optimistic epilogue to the story. The smelter's closing may actually prove beneficial in the long run, though that's little consolation for those losing jobs now. Shortly after EPA's hearings wound down, SRI International, a consulting firm that had been examining the area's economic potential, reported that "Tacoma should accept the inevitability of the loss of such resource-based plants as Asarco and move as quickly as possible to a new economy based on technology and services." Tacoma, the consultants said, cannot have both, and has few prospects for attracting more traditional manufacturing. Their conclusion: "The industries with the most long-term growth potential for the Tacoma area, such as electronics, computers, accounting, and legal services, simply do not locate near copper smelters, chemical plants, and paper mills."

BARNETT N. KALIKOW is a free-lance writer in Tacoma, Wash., who often reports on health-related issues.

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Continued from page 5

The Bio-Cam system, which gives slower foot motion in the power-producing downward part of the pedal stroke and faster foot motion at the top and bottom, has the disadvantage of mechanical complexity. The transmission system we now use is one of the simplest and lightest imaginable. The pedals are linked directly to the propshaft via a steel-cable chain. No derailleur and freewheel mechanisms are required. The Bio-Cam and similar systems require a freewheel mechanism along with the usual cams, followers, and pushrods, and thus inevitably add weight. Added weight exacts a far greater performance penalty on an airplane than on a bicycle.

Reliability is also of great concern. Losing power in a turn through mechanical failure can be disastrous in a human-powered aircraft, unlike in a bicycle. The bottom line is that a conventional single-speed bicycle pedaling system looks more attractive than the Bio-Cam for human-powered aircraft. Future technological developments might change that situation.

The CO_2 Threat

Journals often ignore the work of Amory Lovins, who in analysis after analysis shows the potential economic, social, and environmental advantages of making intensive efforts to conserve energy. However, David J. Rose, Marvin M. Miller, and Carson Agnew (*"Reducing the Problem of Global Warming," May/June, page 48*) surely go too far when they present Lovins' thesis as their own. It is even more disturbing that the two analyses adopt similar approaches to modeling world energy use and CO_2 emissions under different sets of supply and demand assumptions.

David Brooks
Ottawa, Canada

The authors respond:
Our article was based on the results of a two-year study in the report of which we discuss the work of Lovins et al. on the CO_2 problem in detail. Our main area of agreement with these authors is in the feasibility of reducing energy demand by improving the efficiency of energy use. However, we are in basic disagreement on such issues as the need for and prospects of nuclear power and the potential contributions of other energy sources such as biomass. We did not highlight these other points in the article because of space limitations and the fact that our differing views on nuclear power are well known.

While we applaud Lovins' important role in raising awareness of the potential for reducing energy demand, we also note the substantive contributions by many other individuals, both in the United States and elsewhere. These include the members of the Energy Conservation Program at the Oak Ridge National Laboratory, which was started by one of us (David Rose) in 1971.

Fission Gas?

In "The Reactor of the Future?" (*February/March, page 52*), Lawrence Lidsky says that "no radiation will leak from the [high-temperature gas-cooled reactor fuel] particles at temperatures below 1,600°C." Actually, a large amount of radiation in the form of gamma rays would "leak" from particles in the core of an HTGR reactor. Perhaps he meant fission gas instead of radiation?

Gerard P. Cavanaugh
Windsor, Conn.

Professor Lidsky responds:
Strictly speaking, Mr. Cavanaugh is correct. The exact term for "radiation" in that sentence should have been "volatile fission products." I decided the term would be difficult to explain for a general audience. The point is that gamma radiation is strictly a local phenomenon and does not induce radioactivity. Nothing is released into the coolant gas that could escape into the confinement vessel or the atmosphere in the event of an accident in an HTGR reactor.

Firestopper

There is a third party in the controversy between proponents and opponents of using plastic materials in buildings and furnishings. (*"Where There's Smoke, There's Ire," April, page 68.*) The fire-resistant/smoke-suppressant (FR/SS) chemical industry adds chemicals and minerals to plastic resins to reduce both their flammability and smoke output. In a recent analysis, I found that the FR/SS chemical industry is a half-billion-dollar market sector with an annual growth of 6 percent.

As the author points out, there is no accepted test to identify which construc-

tion materials produce a given level of toxic smoke. Many chemists feel that no test can prove that plastic smoke is more toxic than wood smoke. However, the author fails to point out that many fire victims die from lack of oxygen. In fact, many who die from inhaling carbon monoxide or other toxic products would suffocate anyway. Since any fire consumes oxygen, a primary goal should be preventing its ignition and spread in the first place. Nobody seriously suggests that wood be eliminated as a construction material. Therefore, the answer lies in using flame-resistant plastics and in combining flame-resistant and smoke-suppressant chemicals with existing plastic systems.

Donald Saxman
Missouri City, Tex.

Disposal of Nuclear Wastes

While *Technology Review* tried to give a balanced view of nuclear power development in "R_x for Nuclear Power" (*February/March, page 33*), you overlooked a very important factor. This is the extraordinary dimension of the nuclear-waste problem, which has no real solution in sight. Nuclear waste stands as a permanent, dangerous legacy for this country and the world. It is the height of social irresponsibility that institutions blessed with great talent, technology, and financial resources have failed to address this problem with the same zeal they have shown for developing new reactor designs.

Those who have worked for decades to educate the public and resolve this problem are discouraged by the fact that resources are being channeled into further developing this technology with no thought to its social consequences.

Mary Sinclair
Midland, Mich.

Nuclear reactors will be a good idea when safe disposal of wastes and freedom from potential sabotage are assured. This means that nuclear reactors are not and never will be either safe or wise. A new design is only a patch on a festering wound. We are at a unique point in technological history, in which we can make the intelligent and humane choice to turn away from nuclear power. The best prescription for nuclear power is to clean up the existing mess before it grows further beyond control.

David Kellogg
New York, N.Y.

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FORUM/CONTINUED

Continued from page 11

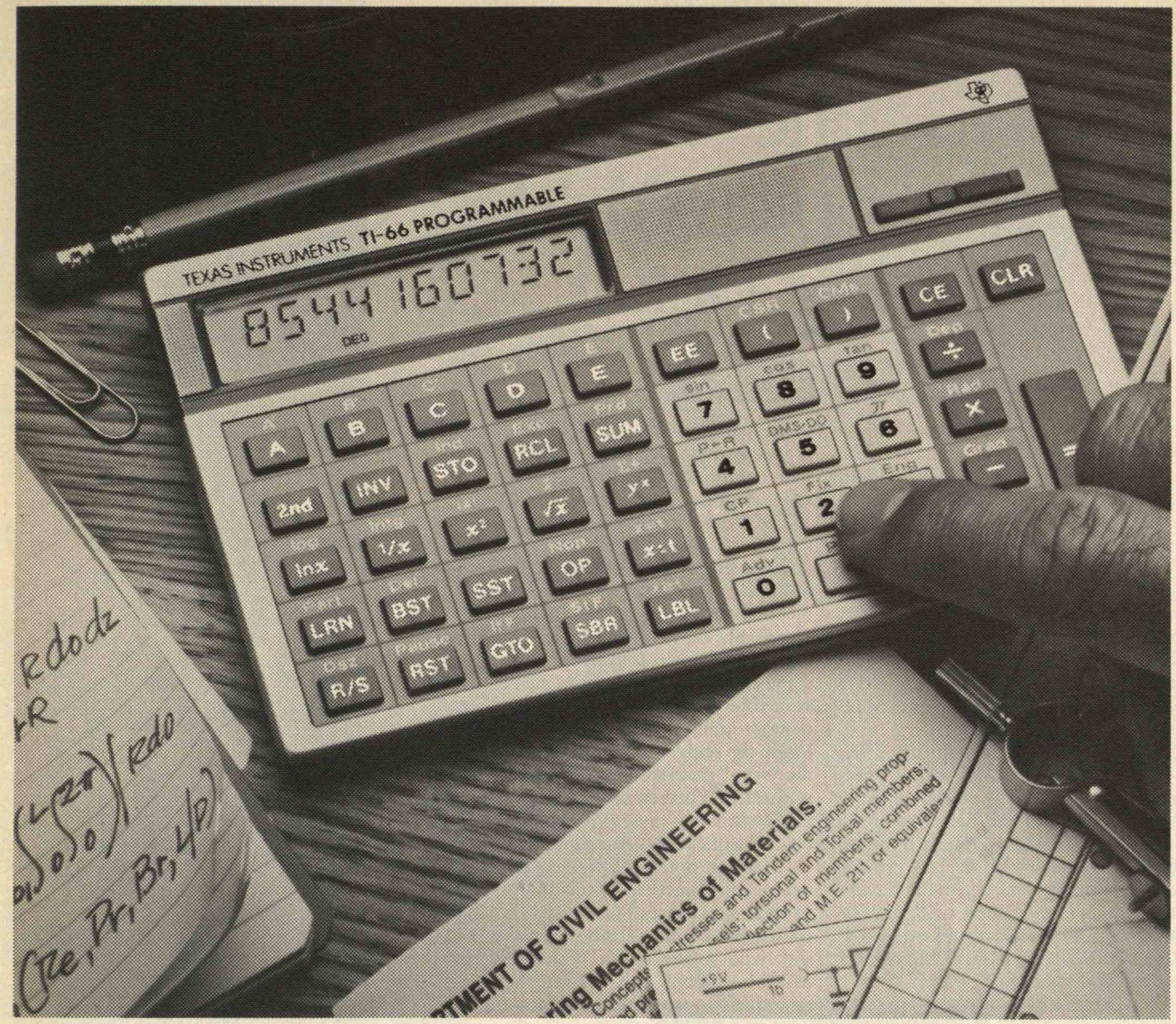
Furthermore, since many marriages are made within the company and many others are arranged by company supervisors, there is a certain assurance that the wife will conform to her husband's customary overtime and collegiate drinking habits. As Satoh notes, "You miss an essential working environment in Japanese society if you don't have regular drinking partners from work."

Women do not often accompany their husbands on overseas trips, and cases of two or three years of separation are not unheard of. Ostensibly, this is to facilitate proper child rearing and education, which are the exclusive domain of mothers and the Japanese national school system. Women in my company are hardly complacent about this state of affairs, but, unfortunately, there is every indication that it will take years to alter the pattern of sexual inequality that seems firmly rooted in Japanese society.

However, I would like to tread cautiously with the idea that certain cultural and ideological characteristics are indigenous to Japanese society. Such concepts nourish the misleading assumption that the Japanese worker is a species apart—both in motivation and morality. I find instead a familiar mix of banality and idealism among the workers I live with. There is a real desire for frankness and efficiency; for instance, my colleagues frequently complain about functionally useless overtime such as reading a novel for two hours while waiting up for a superior. Most employees say they would prefer to use this time to meet women outside the company environs.

The pleasures young workers obtain through their jobs figure heavily in what they value about work: color TVs, cars, clothes, spending money. Married men tend to dwell on discussions of living space for their families and some sport or hobby they hope advancement will give them time and money for. Some workers are quite enthused about their daily responsibilities, but few discuss their attachments to their jobs in terms of company loyalty or the importance of the work ethic. Work is more often a demanding and necessary means to an end.

Japanese management practices afford companies like my own the means to demand the most of their human resources. These methods deserve attention as the primary mover in Japan's headlong rush to become an industrial colossus. However, I think that it is wrong to embrace them without acknowledging the price they exact and the seeds of discontent they have sown. Credit should go to the Japanese themselves, not for the peculiarity of their race, but for the peculiarity of their sacrifice. □



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The Microscopic World in Living Detail

BY ALISON B. BASS

DEEP within the body, a millionth of a meter wide, live capillaries with gnarled, tree-like branches. Kidney cells grow in delicate, coral-like formation, and bizarre-looking scavenger cells glide across the surface of the lungs in search of foreign prey. Long invisible under microscope, this teeming subcellular universe can now be seen alive and in three-dimensions with techniques developed by Professor Alan Nelson and his colleagues at M.I.T.'s Whitaker College of Health Sciences, Technology, and Management.

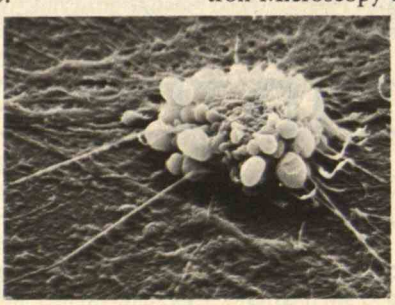
The new technology combines the power of computer analysis with an electron microscope specially built to magnify living tissue samples and display them in 3-D on a video screen. Originally developed to help biologists unravel the cellular structure of the human body, these techniques are also being used to determine the durability of ceramics and other materials and the quality of integrated circuits on a semiconductor chip.

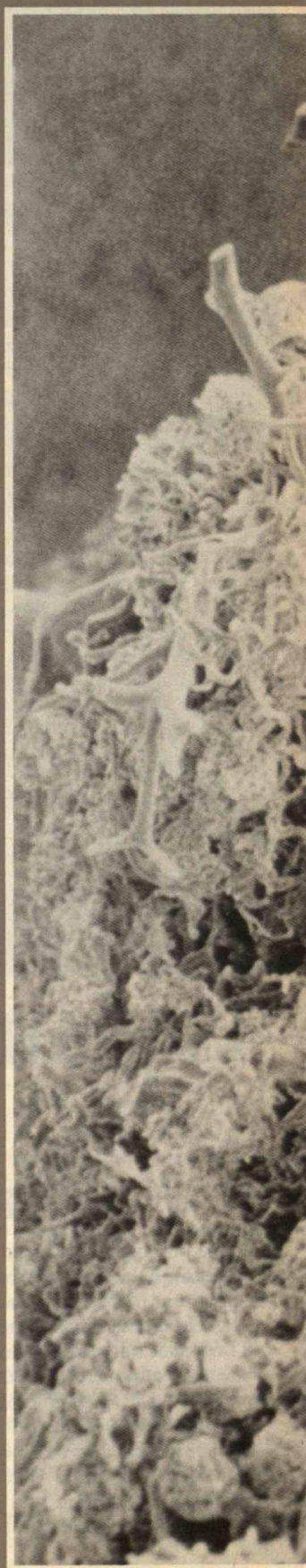
"What makes this work important and unique is its combined approach," says Thomas Hayes, deputy director of the Donner Biomedical Laboratory at the University of California, Berkeley. "Each of these techniques gives us information we've never had before; used together, they are far more than the sum of their parts."

The electron microscopy technique is similar to computer aided tomography (CAT), a method of collecting data from multiple angles and using a computer to reconstruct those data into an image on a screen. But the new process, which Nelson has dubbed microtomography, differs in some important aspects. A medical CAT scan rotates an x-ray beam around a patient, producing a detailed picture of tissue inside the body. But in microtomography, the "scan" stays stationary and the sample is rotated. Furthermore, the device uses electrons, not x-rays, to probe the varying densities of the target sample.

"Electron optics allow us to make our beam source incredibly small. If we tried to make the source of the x-rays that small, we'd melt the x-ray tube,"explains Nelson, who is director of Whitaker's Electron Microscopy Lab. "When the size of the radiation source becomes as small as your target, you can get very high resolution."

At the lab, researchers can collect data using either a transmission electron micro-





Shown above is one of the first micrographs of a living cell, magnified 3,000 times.

In conventional microscopy, living cells cannot survive the conditions required to prepare them for exposure to an electron beam. Researchers must dry and coat the cells with a film of metal to ground them electrically and improve their resolution. M.I.T. scientists can now examine living cells under the electron microscope by keeping them inside a specially designed environmental chamber. The cell above is a macrophage—a scavenger only 50 microns wide that feeds on foreign substances and unhealthy cells. Here it glides across tissue surface using long "pseudopods" (fake feet) to sense prey.

In the outer layer of the kidney, clumps—or glomeruli—of tiny blood vessels grow in delicate, coral-like formation. These vessels, the smallest specialized capillaries in the body, perform a vital function: they cleanse the blood of impurities. Microtomography provides the first glimpse of these intact capillaries at incredibly high resolutions: the glomeruli in the micrograph at the left are only 10 to 100 microns (millionths of a meter) apart. Even higher resolutions reveal a single glomerulus of closely woven capillaries (below).

The new technology combines the power of computer analysis with an electron microscope built to magnify living tissue.

scope (TEM), in which an electron beam passes through a thinly sliced sample, or a scanning electron microscope (SEM), in which a tiny beam is directed rapidly over the sample's surface. Both techniques yield resolutions better than a millionth of a meter; that is, viewers can perceive the difference between two points that are only that far apart. With this kind of resolution and magnifications that exceed 50,000 times, microscopy has finally reached the subcellular level of the human body.

Living cells, however, cannot be viewed under conventional electron microscopy. Since biological materials are poor conductors, they usually retain an electric charge when struck with an electron beam and end up repelling it. This distorts the data. To overcome the problem, the sample must be coated with thin metal films to make it conductive—a fatal procedure for living cells.

Nelson and his colleagues have designed a chamber that preserves the cells in a normal environment yet allows the electrons to "peek through." The electron beam is maintained in an incredibly strong vacuum by a complex network of pumps that keeps out air and any other molecules that might absorb the electrons before they strike the sample.

"Basically, we squirt the electron beam through pinholes into the environmental chamber, and these pinholes are small enough to reduce the number of air molecules that escape," Nelson says. He has also devised a way to remove the surface charge that inevitably collects on a biological sample; however, the details of how that works are a trade secret. When the electrons hit the sample, they give off signals that are picked by a detector and fed into the computer.

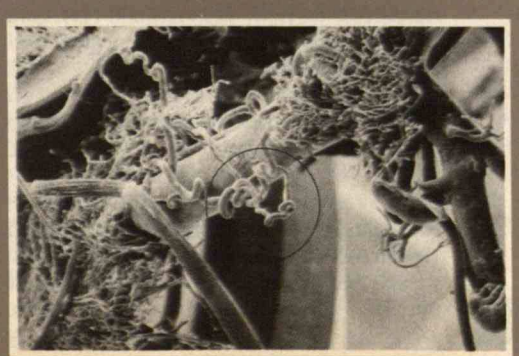
The Whitaker researchers use these signals to create a continuous 3-D image. This effect, which can be seen without the polarized glasses used for viewing movies in 3-D, is achieved in much the same way a moving picture is produced from film sequences. Images of the sample—one tiny slice at a time—are reflected through a vi-

1

Electron microtomography has led researchers to a startling new theory that explains how tumors spread through the body. Studying rat cells at magnifications that exceed 50,000x, scientists have discovered that the tiny blood vessels surrounding a tumor grow in distorted, leaky shapes. In a healthy rat, these vessels are shaped like smooth, round pipes. But in a cancerous rat, the capillaries look like the gnarled branches of a dying tree (1); flat, swollen sheets of membrane that engulf normal blood vessels (2); or even tiny corkscrew spirals (3).

"These abnormal capillaries have holes so there's immediate contact between the bloodstream and the tumor cell," explains Dr. Richard K. Babayan of Boston University School of Medicine, who is collaborating with M.I.T. professor Alan Nelson. "These holes may permit the tumor access to the rest of the body."

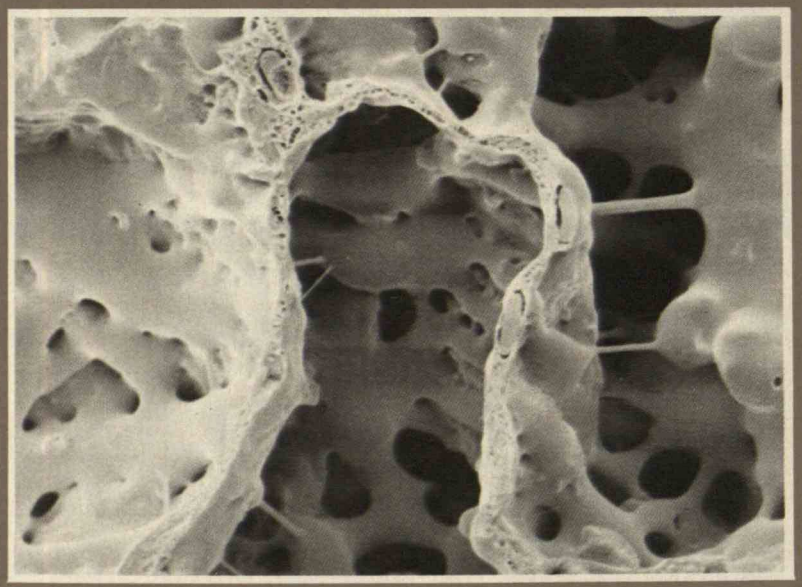
If this theory holds true, plugging up the holes by clotting the leaking vessels may stop the tumor in its tracks. "If we introduce a coagulant into the tumor, it might reduce the blood flow and keep it from spreading," says Nelson. The group is now testing the theory in lab animals.



1

2

These electron micrographs show a sample of frozen lung tissue at successively higher magnifications. At 118x in (1), the lung has been cracked open to reveal the alveoli, the spongy pockets of tissue that pump carbon dioxide out of the lung and oxygen into it. In (2), a single artery has been cracked in half and photographed at 1,180x. Hundreds of tiny capillaries lie exposed, revealing squashed red blood cells. At 1,580x in (3), a single alveolus has been split open, showing an individual capillary with blood cells flowing through single file. At 12,000x, (4) focuses on one capillary and the single blood cell trapped inside its membrane walls.



3

4

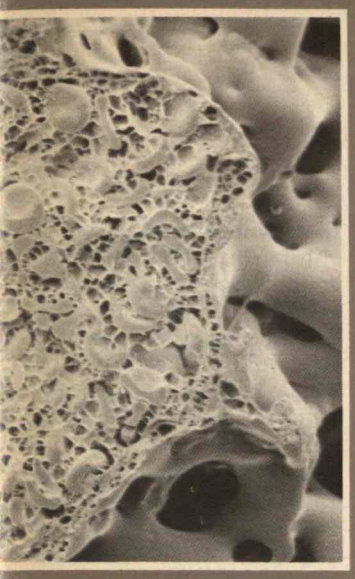
Harnessing the "third dimension" to an electron microscope permits scientists to view the actual structure of microscopic matter.

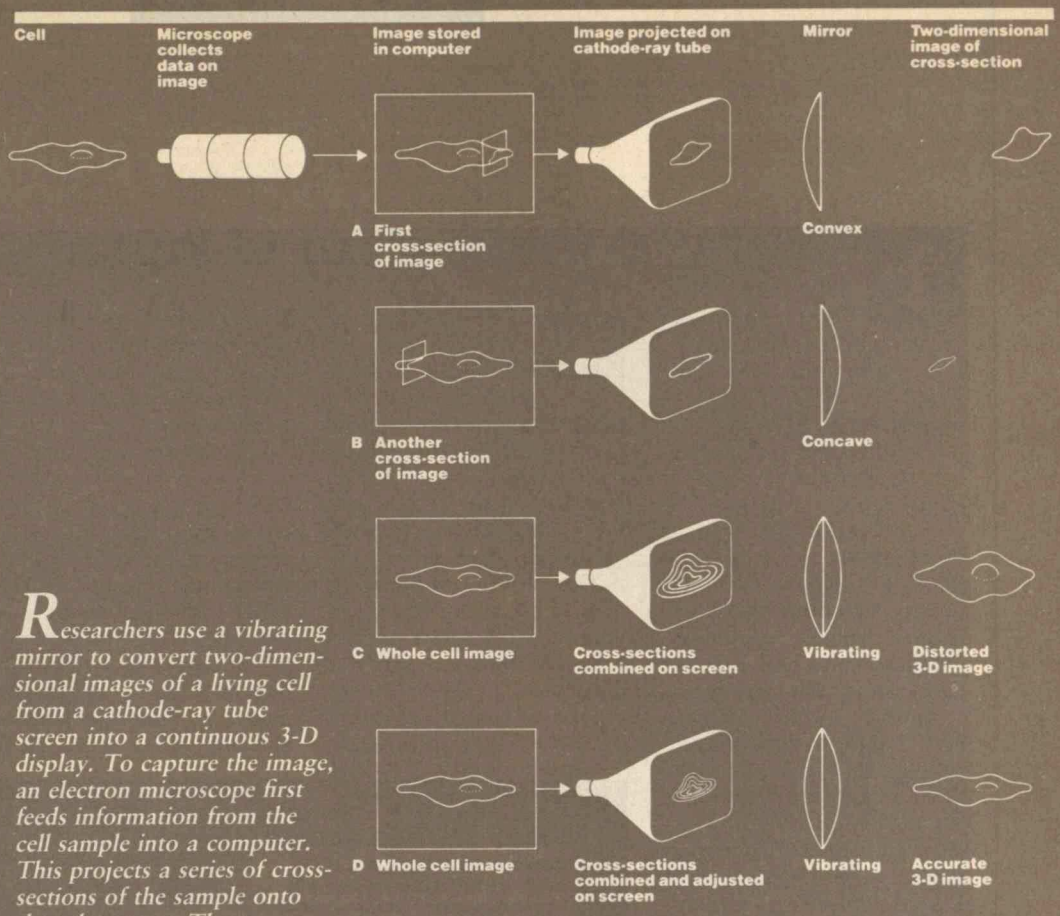
brating mirror onto the display screen in a sequence so rapid that the eye sees them as continuous. This 3-D technology was developed by Bolt, Beranek and Newman in Cambridge, Mass., and Genisco Computer Corp. in Costa Mesa, Calif.

Harnessing the "third dimension" to an electron microscope permits researchers to view the actual structure of microscopic matter—be it a living cell, a ceramic particle, or a silicon chip—for the first time. Scientists at M.I.T.'s Ceramics Processing Research Lab have already used the device to determine the size and distribution of particles in submicron ceramic powders. "We can see how uniform the particles are," explains Paul White, one of the researchers. The more uniform the particles are, the stronger the ultimate ceramic product will be.

The first commercial application of this technology may come from its ability to examine the three-dimensional structure of rocks extracted from the earth. "When you're drilling for oil, it's nice to know the stability of the rock through which you're drilling," says Nelson. "With this technique, you'd be able to study a sample of the rock to see if it can structurally support a bore hole."

Nelson says two multinational oil companies have already contacted him about





Researchers use a vibrating mirror to convert two-dimensional images of a living cell from a cathode-ray tube screen into a continuous 3-D display. To capture the image, an electron microscope first feeds information from the cell sample into a computer. This projects a series of cross-sections of the sample onto the tube screen. These "slices" are then reflected by a vibrating mirror.

When the mirror is convex, the image reflected on the other side appears larger and farther away (A). When the mirror is concave, the image looks smaller and closer (B). This is the opposite of the way images normally appear. If the mirror is vibrated rapidly from one position to another, the sequence of cross-sections appears as a distorted three-dimensional image (C).

To correct the inversion, a special computer program adjusts the size of the cross-sections on the screen in synchronization with the vibrations of the mirror (D). For instance, the program enlarges the images when the mirror is concave. The result is an accurate 3-D display of the original cell sample.

the possibility of developing a commercial model of the device. But a prototype is at least a year away, and the technology is now in greatest demand as a powerful research tool.

In biology, the 3-D technique will open a new window on the structure of cells. Sheldon Penman, professor of biology at M.I.T., is planning to use the device to study the intricate architecture of kidney cells. His lab has developed a special casting preparation that reveals the internal scaffolding of these cells and he is eager to examine it in 3-D. "The DNA inside every cell is organized on this scaffolding," Penman notes. "But since nobody could see the underlying structure before, we have no idea what its function is."

Nelson and his colleagues have also devised a new technique for casting biological tissue, principally blood vessels, in plastic. They inject the vessels with tiny polymer molecules, which form a cast that provides an unusually fine view of the vessels' structure. Using this technique, the researchers have discovered that blood vessels surrounding a tumor grow in distorted, leaky shapes. This may explain how a tumor gains access to the bloodstream and spreads through the body.

Although still in the research phase, the microtomography technique for living cells has already been patented by M.I.T. and may eventually be licensed for commercial use. The university is presently negotiating with Cambridge Instruments in England and Japan Electrical Optical Laboratories (JEOL), two leading manufacturers of microscopic instrumentation.

But what Nelson would most like to do is open his facility—with all its special features—to leading researchers nationwide. "In a sense, this technology is research-driven," Nelson says. "I'm always looking for new problems to solve."

Alison B. Bass is a senior editor of Technology Review.

A Deaf Ear to Japan

If Professor Shun-Ichi Iwasaki of Tohoku University in Japan had been speaking his native language, nothing would have happened. But Iwasaki delivered his paper at a 1977 California magnetics conference in English. In the audience, Clark E. Johnson, Jr., and Jack H. Judy were quick to sense the value for the U.S. market of Iwasaki's scheme for high-density recording with a new form of magnetic technology.

Johnson and Judy are now successfully exploiting this technology, but they are worried. As Japanese high-technology research expands, more and more of its results are appearing only in Japanese. How many new opportunities are businesses such as Johnson's fledgling Vertimag Systems Corp. missing?

Johnson's concern is indicative of a widespread problem. Far less information is flowing from Japan to the United States than the other way, a panel of nine experts told the House Subcommittee on Science, Research, and Technology last spring.

This imbalance has three causes:

☐ First, there is the language barrier. Many Japanese scientists and engineers know English because of Japan's concerted efforts to import Western technology, but few Americans know Japanese, and few of those who do are conversant with science and technology.

☐ Second, before the 1970s the United States was very casual about Japanese technology, and U.S. companies made no effort to cultivate networks of informants in Japan. Such networks are now being developed, but they take time to become effective.

☐ Third, the sheer volume of Japanese science and technology publishing—some in English but mostly in Japanese—is immense and hard to track. Many company-sponsored publications supplement professional and trade journals; in all, Japan publishes some 40 percent of the world's patents.

There isn't even a comprehensive list telling which U.S. libraries have which of these numerous periodicals and documents. Less than 20 percent of the contents of the periodicals is available to Westerners through indexing services, said Robert W. Gibson, Jr., head of libraries at the General Motors Research Laboratories.

U.S. abstracting services also cover Japanese science and technology poorly, according to members of a workshop on U.S.-Japanese technology transfer held at M.I.T. *Chemical Abstracts* is probably doing the best job, but it covers only about 10 percent of all chemistry papers published in Japan—and only about 4 percent of those written in Japanese.

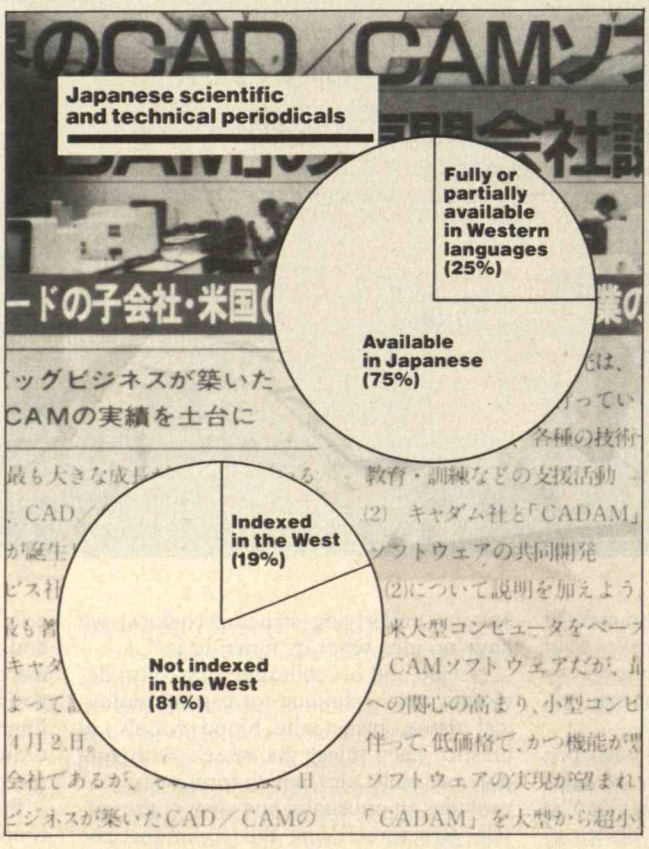
Johnson's company has found a Japanese-speaking engineering student to translate articles of special interest. And Johnson is fortunate, too, in belonging to the Magnetics Society of the Institute of Electrical and Electronics Engineers, which plans to translate some 1,500 pages a year (at a cost of $25 to $50 a page) from two Japanese journals and several convention proceedings.

However, Johnson says, the Japanese Institute of Electronic and Communication Engineers publishes 25 other technical periodicals that also should be translated; he thinks the U.S. government should provide seed money to make a start on the job. There's a precedent, he says, in the National Science Foundation's earlier subsidy for translating Soviet physics journals; today the English editions of these journals are self-supporting.

The language barrier will be tough to break down, though a number of universities are trying. For example, the M.I.T.-Japan Science and Technology Program provides one-year internships for M.I.T. graduate students in Japanese industry. However, those who participated in the first two years of the program had to acquire their Japanese at nearby Harvard because M.I.T. doesn't teach the language, according to Professor D. Eleanor Westney, the acting director of the program.

Educating a new generation of scientific and technical specialists who know Japanese, Westney believes, requires a "long-term investment that only the federal government is in a position to make."

—*John Mattill* ☐



Japan's prodigious publishing industry produces over 9,000 technical periodicals, but Western researchers have very limited access to them. That's because only 25 percent are available in English and even fewer are covered in Western indexes. (Data: Robert W. Gibson, Jr., head librarian, General Motors Research Laboratories)

Ocean Uranium: Limitless Energy?

As the sailing vessel *Regina Maris* plied the waters of the Atlantic this past summer, Jeff Jimenez, an M.I.T. ocean engineering student, dangled astern a hank of acrylic-amidoxime yarn, a material that collects the uranium ions dissolved in seawater. This research project is part of a long-term M.I.T. effort, complementing similar programs in Japan, West Germany, and elsewhere, to mine the ocean's enormous uranium reserves. Michael Driscoll, professor of nuclear engineering at M.I.T., believes it could well take 20 years to perfect the technique of mining uranium from the sea. But if the effort is successful, it will make available enough fuel to supply the world with nuclear power practically forever.

Of course, the slumping nuclear power industry scarcely needs more uranium now. But a move is afoot to revive the industry during the nineties, through either better regulation to help reassure the public of safer reactors or reactors with new designs said to be incapable of meltdowns. If those efforts work, or if economic or governmental pressures force a nuclear resurgence, a plentiful source of fuel will be needed.

The most commonly envisioned way to secure fuel is through the breeder reactor. As it produces power, this reactor "breeds" plutonium-239, which can be used as fuel both for itself and for other

The *Regina Maris*, a 144-foot square rigger used for ocean research, has recently been engaged in a project to mine uranium from the sea. The oceans hold enough of this element to provide a virtually inexhaustible source of fuel for nuclear reactors.

PHOTO: OCEAN RESEARCH AND EDUCATION SOCIETY

nuclear reactors. Unfortunately, the plutonium must be separated from the breeder's spent fuel and concentrated, and at that point it becomes weapons-grade, unlike commercial uranium reactor fuel. Many fear that widespread use of breeders would dramatically increase the availability of plutonium for atomic bombs.

That is a major reason why researchers are trying to extract uranium from seawater. If large amounts of the element can be produced cheaply enough, the breeder reactor would not be needed. "You've severed a large connection between the civilian and the weapons side of nuclear technology," says David Rose, professor of nuclear engineering and an energy policy analyst at M.I.T.

Uranium Farms

Estimates are that the oceans hold around 4 billion tons of uranium—enough to supply a worldwide, reactor-based economy for thousands of years. The concentration is very low, though: only a few parts per billion of seawater. Achieving commercial success in extracting the fuel would require moving a great deal of water past an effective uranium absorber.

Promising uranium absorbers range from titanium oxide, which absorbs—"loads"—well but is structurally weak and hard to work with, to a variety of ion-binding resins, such as the acrylic amidoxime used by the *Regina Maris*. This yarn is cheap and its many fibers have a large surface area and load fast. Japanese researchers have loaded acrylic amidoxime with uranium to concentrations approaching terrestrial ore's 1,500 parts per million. "If you can load something to 1,500 parts per million, you've got synthetic ore," says Driscoll. The uranium can be stripped from the resins with acid, much as terrestrial ore is treated.

The next question is how to get enough water past the absorbing medium. "To supply one reactor steadily you would need a water current something like that of the Nile River passing through your system," says Driscoll. One of his studies showed that in actively pumped systems, the pumps and the power to run them will account for some 40 percent of the total cost of the uranium. Instead of trying to move water, Driscoll favors using passive systems resembling giant kelp beds to absorb the uranium, with acres of acrylic-amidoxime "mops" as the kelp.

He thinks such systems could extract uranium for around $150 a pound. That's far above the $20 a pound that uranium oxide now commands on the world spot market; however, as terrestrial sources dwindle, the cost will rise. Most important, even if ocean uranium costs $150 a pound, standard reactors using it would still be competitive with a nuclear power system based on the breeder reactor.

Although no one is now planning to build a commercial seawater extraction facility, Japan is constructing a research unit that will use active pumps to generate about a kilogram of uranium annually. Driscoll thinks the Japanese project will say a lot about whether extracting uranium from the oceans is practical. "It's big enough to test all the operations involved," he says. The relatively small efforts required to assess ocean extraction—particularly compared with the mammoth commitments necessary to develop the breeder reactor—seem well worthwhile.—*David Kennedy* □

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CVT: A New Transmission

Late this year or early next, some small cars sold in Europe by Fiat, Ford, and General Motors will be equipped with a significant innovation: the continuously variable transmission (CVT). Unlike a typical transmission with gears—where, for a given engine speed, first gear allows the wheels to run slowly and fourth allows them to run fast—the CVT changes continuously from low to high. It promises to provide the operating ease of a conventional automatic with fuel economy as good as or better than that of a five-speed manual.

Transmissions can increase an automobile's mileage by allowing the engine to run as much as possible in its most efficient state. This is generally in the middle of its speed (rpm) range, and at around three-quarters throttle. A five-speed transmission is more economical than a three-speed because the extra gears mean that, at any given road speed, the engine can be running closer to this ideal point. Since the CVT allows the speed of the engine to vary continuously, it can run near this ideal point even more of the time.

Developed jointly by Ford, Fiat, Borg-Warner, Volvo, and the Dutch government, the new CVT uses two pulleys connected by a steel belt. One pulley, driven by the engine, turns the steel belt, which rotates the other pulley to drive the wheels. The diameter of each pulley is changed by a hydraulic control mechanism: a larger wheel-drive pulley makes the wheels go slowly for starting the car, and a larger engine pulley makes the wheels go fast for highway driving.

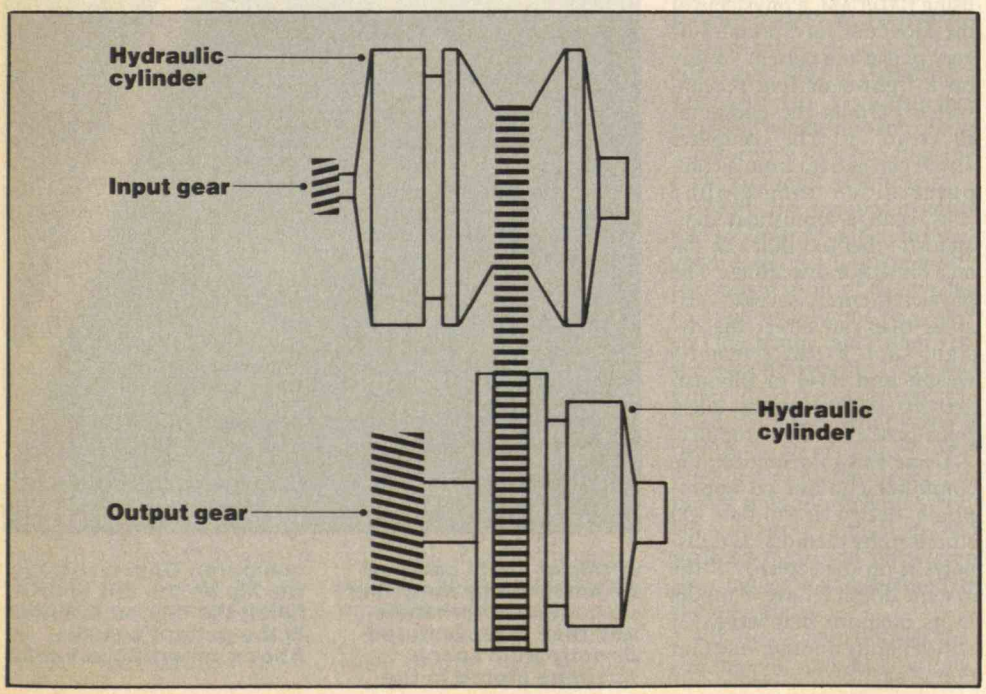
During normal operation, the hydraulic control adjusts the pulley diameters so that the engine runs close to its most efficient range. But the CVT allows the engine to run through its full speed range during acceleration.

So far, a car equipped with the CVT gets about the same mileage as one with a five-speed manual, but Ian Macpherson, director of powertrain research for Ford, says that much of the hydraulic system can be replaced with electronics to achieve even better efficiency.

Industry observers frowned on a cranky, sluggish, rubber-belt CVT that saw limited service in a few small European cars beginning in the fifties, but the same observers are enthusiastic about the new device. "This CVT improves performance, can be programmed to improve fuel economy, and is reasonably compact," says Philip Gott, senior engineering consultant for Arthur D. Little's automotive unit. Fiat has run taxi-fleet tests with CVT prototypes, and industry observers say the drivers were enthusiastic. "We believe that when CVTs come out, the sales will be limited by production capacity, not market acceptance," says Gott.

That doesn't mean private car owners will have nothing to get used to. The faster the CVT's hydraulic control system operates, the more energy is required to pump the hydraulic fluid. To reduce this energy consumption, engineers allowed a somewhat slower response time than would have been ideal. "There's a slight but noticeable delay in the vehicle's acceleration," says an industry source. "It's rather similar to waiting for a turbocharger to pick up." In addition, drivers won't be able to rely on the sound of the engine to tell how fast they're going: in its search for efficiency, the CVT will often be changing the engine speed on its own.

Analysts aren't too con-



This transmission, to be introduced in some European cars late this year or early next, uses a steel belt running between two pulleys. The pulleys' diameters can be changed: the sides of the top pulley are separated, giving it a small diameter, while the sides of the bottom pulley are pressed together, giving it a large diameter. As the pulleys' diameters are altered by the hydraulic control, their relative speeds change. Thus, the relative speeds of the input gear, turned by the engine, and the output gear, which turns the wheels, also change.

This "continuously variable transmission" (CVT) changes relative input and output speeds smoothly, rather than in the distinct steps (first gear, second, and so on) of today's standard and automatic transmissions.

DIAGRAM: OMNIGRAPHICS

cerned about these issues, though. "If the technology holds up in actual use and manufacturing costs are reasonable, then CVTs will be attractive," says John Heywood, professor of mechanical engineering and director of M.I.T.'s Sloan Automotive Lab. Gott is confident that CVTs will cost less to manufacture than conventional automatic transmissions.

At least for a while, the new transmissions will be seen only on relatively low-powered cars; CVTs can't yet handle much more than 100 horsepower well, and they are configured for front-wheel drive. However, rumors are that Ford will put some in U.S. cars within two to three years.—*David Kennedy* □

Designing Artificial Joints by Computer

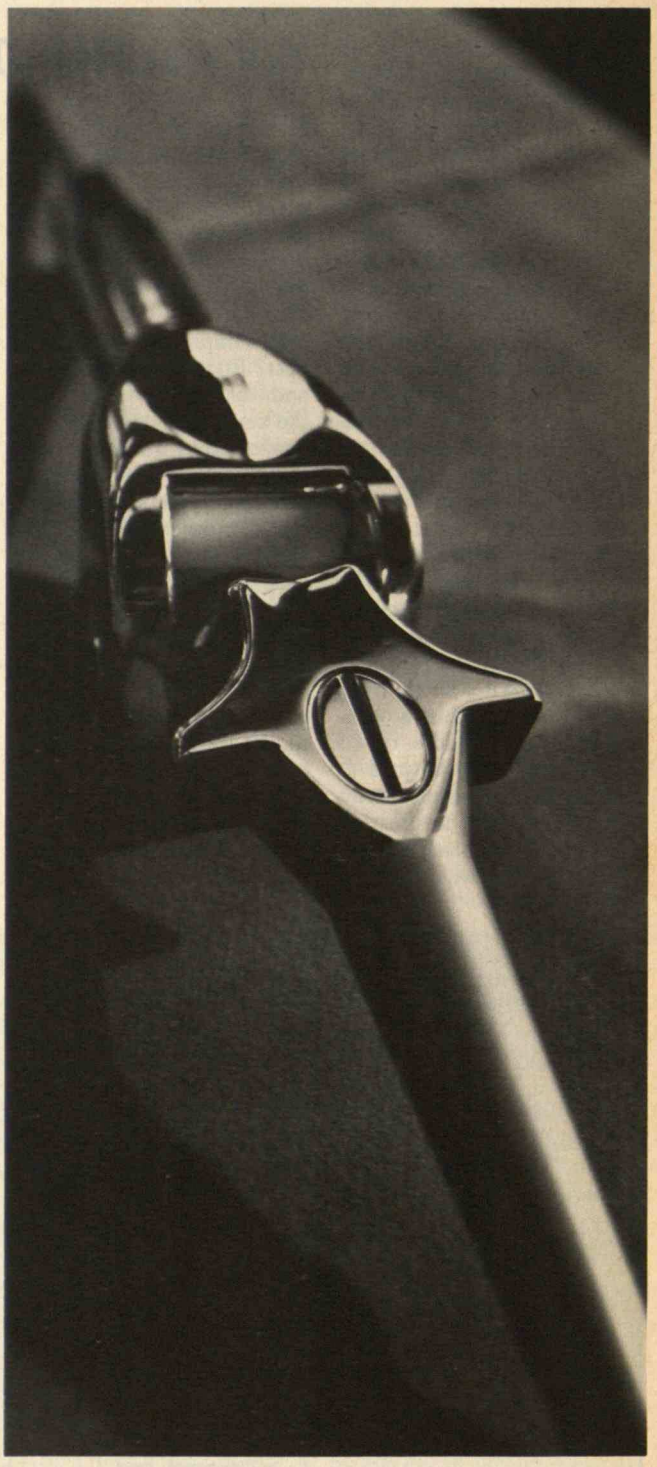
Despite the best efforts of bioengineers, the process of making artificial hips, knees, and other joints used to be an imprecise craft. To duplicate the complex joints required for walking, a designer painstakingly drew a model for a prosthesis from a patient's x-ray. Then a technician took a block of metal, machined it with tools such as lathes and milling machines, and carefully finished it by hand, filing off a bit here and rounding a rough edge there, trying to shape the metal to fit the patient. Even so, at the operating table, the surgeon often had to cut away extra bone and tissue to make the prosthesis fit.

Now this hand method is giving way to a faster and more precise computerized system. "We're in the business of making the prosthesis fit the patient, not the patient fit the prosthesis," says Donald Broas, executive director of the Hospital for Special Surgery in Manhattan, where one such project is underway.

This new sort of CAD/CAM system—for computer-aided design and computer-aided manufacture—is in use at some leading prosthesis manufacturers such as Zimmer and DePuy, and is sharply cutting the waiting time for joint-replacement surgery. Making a customized joint at the Hospital for Special Surgery used to take twelve weeks; CAD/CAM reduces this to two weeks. It also lowers the hospital's cost of producing an implant by an average of 20 percent.

To design an artificial joint using CAD/CAM, a physician at the Hospital for Special Surgery places the patient's x-ray on a light-sensitive screen, which permits the computer to "read" it. The computer also receives data from a computer aided tomography (CAT) scan, a sophisticated diagnostic method that can detect bone abnormalities. The physician enters several variables that can affect the design, such as the patient's weight and level of physical activity, and answers questions posed by the computer.

Using this information, the computer chooses an appropriate design from the 300 stored in its memory and displays it on the screen. "If the system doesn't have a model in its memory that works, it will generate another one that does," says Broas. Finally, the



Artificial joints can now be designed by surgeons on computer terminals, and then manufactured directly from specifications stored in the computer. Opposite page: the hip on the left is artificial; the one on the right is the patient's own. Above: an artificial knee.

physician rotates the design and looks at it from different angles, making changes to assure the closest possible fit with the patient's bone structure.

When the model is just right, the CAD equipment produces a punched tape containing the precise design coordinates for the implant. The tape then goes to the machine shop, where it runs CAM equipment such as lathes and milling machines that cut the artificial joint out of blocks of titanium or other materials.

The procedure works similarly at Zimmer and DePuy, except that surgeons send patients' x-rays and CAT scans to the company, where technicians use CAD/CAM systems to produce the prostheses. The finished joints are then shipped back to the surgeons.

Johnson & Johnson, the pharmaceuticals company, obtained the license for the Hospital for Special Surgery's system and plans to offer it to hospitals throughout the country next year. Physicians will be able to design prostheses themselves by using terminals in their hospitals to gain access to a computer at a central facility run by Johnson & Johnson. The computer's software will contain all the structural design criteria, so "the doctor won't have to worry about not being an engineer," says Timothy Wright, a bioengineer at the Hospital for Special Surgery.

Once the prosthesis has been designed, Johnson & Johnson will either assemble it from off-the-shelf parts or use CAM equipment if custom work is required. And then, of course, the joint will have to be shipped back to the surgeon by the usual means—a necessity that has not yet disappeared despite the advancing electronics revolution.—*Stephen Solomon* □

PHOTOS: JAMES PRINCE

Computer-Aided Surgery

When a patient walks abnormally because of a deformity or an accident, an orthopedic surgeon now relies on experience to decide how to restore a more natural gait. But Robert W. Mann, professor of biomedical engineering at M.I.T., proposes the computer as a more powerful tool to plan and carry out such surgery.

His idea builds on previous work in designing artificial limbs with the computer. The details of how each person walks, runs, jumps, and climbs stairs are unique because no two people have identical qualities of bone and muscle. Mann and his colleagues have shown how a computer can be used to record a model of a normal gait and then help design an artificial limb that best approximates an amputee's bone and muscle structure.

Such computer-based analyses would have special power in the hands of a surgeon operating on a patient with an abnormal gait, says Mann. Today's surgeon can only " 'try out' a solution in the operating room and wait for the patient to recover to observe the consequences." In contrast, Mann sketches a scenario for a computer-modeled osteotomy to correct a deformity by changing the bone and joint alignment:

"With the computer light-pen serving as scalpel, the surgeon assesses the proper size and orientation of the wedge of bone to be removed, 'severs' the femur, and 'removes' the bone fragment. The computer then reconstructs the bone (as nature would over a much longer time) and modifies its model of the patient's musculoskeletal structure to give an animated walking figure on the screen the changes in gait dictated by the operation.

"If the surgeon decides that this first choice is not optimal, the procedure can be started anew merely by erasing the screen," says Mann. This simple process can be repeated as often as necessary until the surgeon has found the best solution to the problem.

This approach is analogous to computer-aided design (CAD), where a computer is used to design and test a device before it is built. And Mann thinks it may be possible to go one step further, giving the surgeon the equivalent of computer-aided manufacture (CAM). The computer could help guide the surgeon's hand during the operation, just as the computer directs the machine that manufactures the device it has helped design.

But surgeons need not worry, says Mann; their role is secure. "Clearly, in computer-aided surgery, we wish to capitalize on, and in no way diminish, the knowledge and skills of the human operator."—*John Mattill* □

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Continued from page 9

ing some form of job security. If this leads to lower turnover rates, American firms may gear up their training programs.

In Europe, some technique must be found to lower the fixed costs of adding employees to new and small enterprises. This could be done with a dual system of mandated fringe benefits in which the charges to the employer would be smaller during the first five years of an individual's employment than later. A dual system of job guarantees could also be established that allows new and small firms more freedom to hire and fire than large firms. But we must recognize that any such system would create a two-tiered social safety net, in which certain employees would end up with more job security and higher incomes than other employees.

To some extent, the Japanese have the best of both worlds with their system of lifetime employment. But they pay a price in that it is virtually impossible for Japanese employees to change jobs to improve their opportunities. Finding the right mix between economic security and insecurity is a task that confronts Europe, Japan, and the United States. It is easy to argue that none of the three has yet found it.

Continued from page 17

miracle of life. He urged a holistic approach to the study of living organisms.

Fortunately, the blatant discrimination faced by black scientists of Just's era has faded. Universities and corporations actively seek black scientists, and even the Reagan administration's weak commitment to civil rights does not seem to have affected employers' determination to increase their precentage of minority professionals. Nevertheless, as black and other minority scientists can attest, not all the obstacles have vanished. Perhaps the doors have swung open on the ground floor, but the hinges of those at higher levels are a bit stiff.

However, Manning does not specifically relate Just's experiences to contemporary circumstances. He simply tells his story well, leaving the reader to decide what lessons it teaches. □

ROBERT K. WEATHERALL is director of the Career Services and Preprofessional Office at M.I.T.

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Turbochargers, electronics, advanced transmissions, knock sensors, fuel injectors and other sophisticated devices are being rapidly incorporated into today's automobiles. While they permit more precisely controlled and optimized vehicle operation, they also place greater demands on fuels and lubricants. Keeping ahead of the changing requirements has challenged scientists and engineers at Exxon Research and Engineering Company (ER&E), and their Exxon colleagues at three major affiliated laboratories outside the U.S.

Hotter Engines

Today's engines are smaller. They operate at temperatures some 50° to 75°F hotter than their older V-8 counterparts. Turbocharged engines run even hotter. Higher temperatures can cause motor oils to oxidize faster, producing sludge and varnish deposits which thicken the oil. This in turn can lead to greater friction and increased engine wear.

In the 1970's, ER&E scientists and engineers discovered an additive technology which resulted in the first fuel-saving motor oil using oil-soluble friction modifiers. Today, they are creating new oils for the hotter engines and subjecting the most promising formulations to grueling tests.

For example, a fleet of New York taxi cabs runs on *Uniflo*® motor oil test formulations for 50,000 miles, using oil drain intervals more than twice those recommended. The taxi engines are dismantled before and after each test to measure wear on critical parts in microns, and to examine engine deposits.

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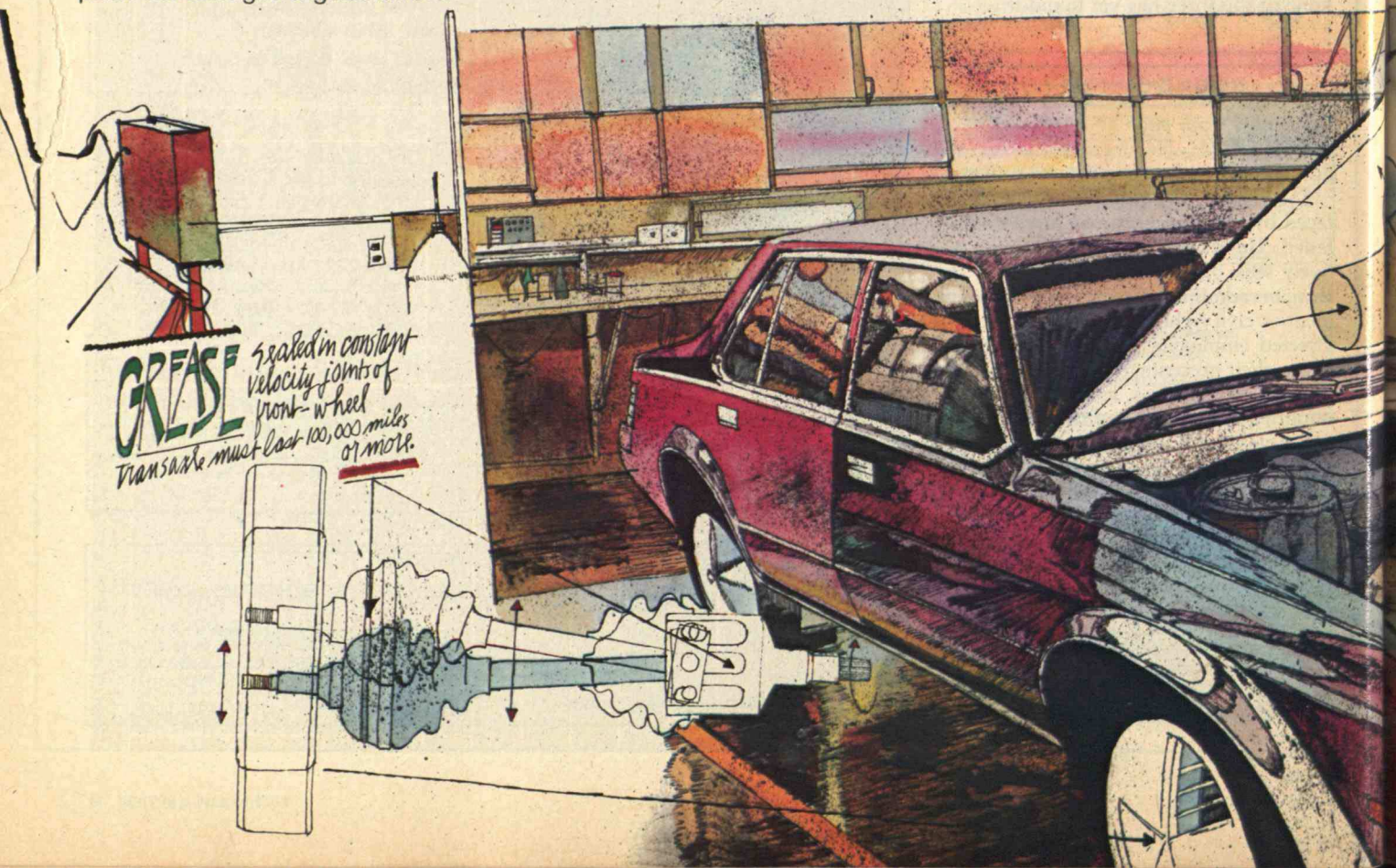
Minimum Oil Film Thickness (MOFT), a patented technique developed at ER&E, electronically measures the protective lubricant film between the bearings and crankshaft of a running engine–sometimes only a fraction of a micron thick. These measurements permit researchers to compare different oil and additive formulations in their search for better wear protection and fuel mileage.

FWD Transaxles

The heat and wear demands of "sealed for life" constant velocity joints in front-wheel transaxles posed other challenges for ER&E scientists in lubricant research. Their response, a lithium-based grease, 5191, can be found in many U.S. front-wheel-drive vehicles,



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Pioneering research at ER&E demonstrated the concept of electronic knock sensors which are now being installed in many of today's cars. These sensors detect engine knock and feed the information to an on-board computer which corrects spark timing to match gasoline octane. This makes higher compression ratios feasible at any given octane level, resulting in more efficient engines.

Changing Fuels for Changing Engines

The continuing replacement of carburetors with fuel injection systems places increasing importance on fuel quality. Gum, varnish, and dirt deposits can clog the very fine holes through which the fuel is sprayed. This results in uneven distribution to some cylinders and reduced engine performance. Ongoing work at ER&E is defining the cleanliness needs of these and future systems and, in parallel, developing fuel quality features to meet those requirements.

Exxon Research and Engineering Company

Improving products for the transportation industry is just one example of the research programs under way at ER&E. A wholly owned subsidiary of Exxon Corporation, ER&E employs more than 2,000 scientists and engineers working on petroleum products and processing, pioneering science and the engineering required to develop and apply new techniques to the manufacture of fuels and other products. For more information on automotive products research or ER&E, write Dr. E. E. David, Jr., President, Exxon Research and Engineering Company, Room 206, P.O. Box 101, Florham Park, New Jersey 07932.

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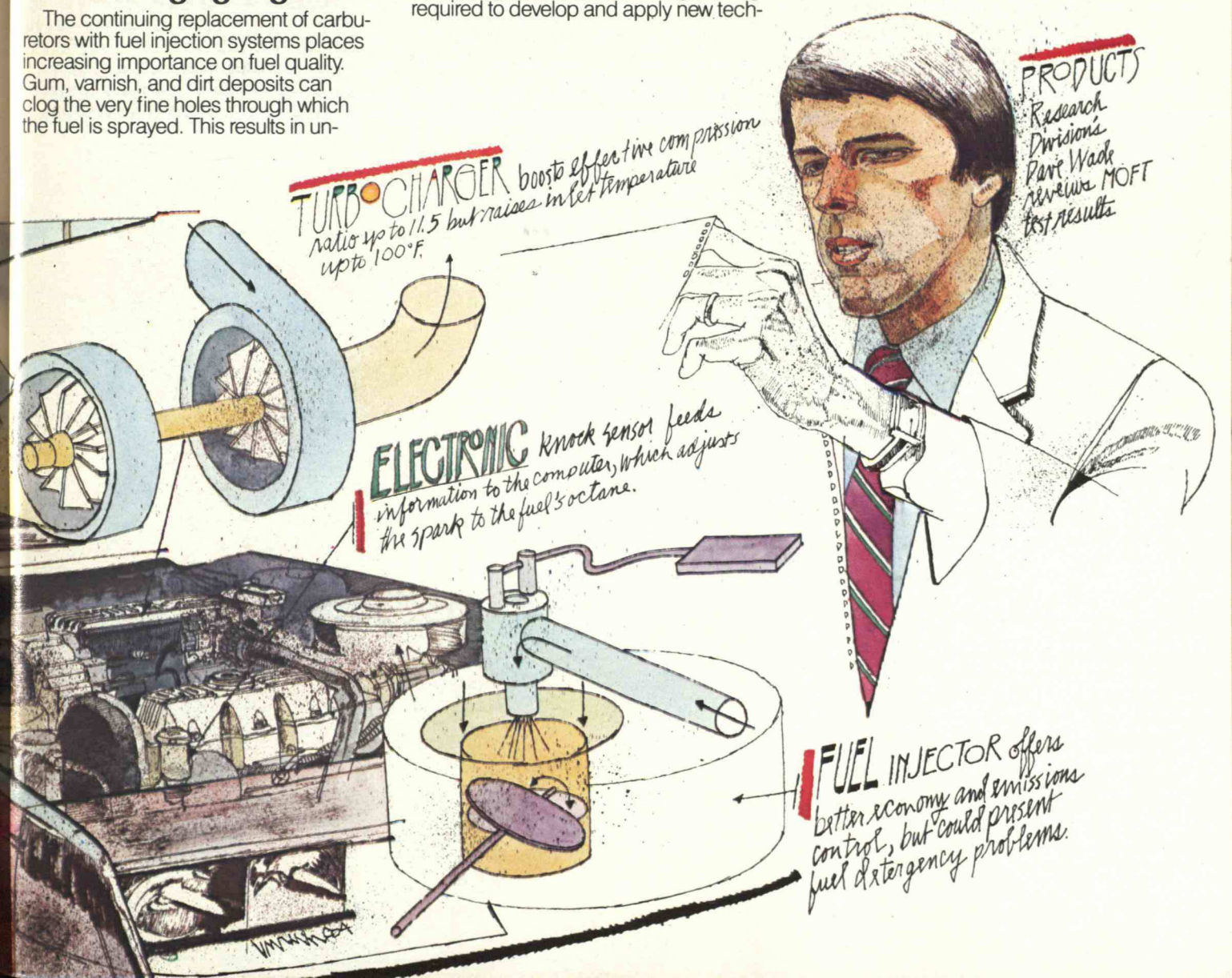


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